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Biological Assessment and Biological Evaluation for Plants

Spruce Beetle Epidemic and Aspen Decline Management Response

Grand Mesa, Uncompahgre, and Gunnison National Forests,
Delta, Garfield, Gunnison, Hinsdale, Mesa, Montrose, Ouray, Saguache, and San Miguel Counties, Colorado

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INTRODUCTION

This document describes and analyzes the direct, indirect, and cumulative effects of the Spruce Beetle Epidemic and Aspen Decline Response Project (SBEADMR), on Threatened, Endangered, and Forest Service Sensitive plant species. This is a project of the Grand Mesa, Uncompahgre, and Gunnison National Forests, Colorado (GMUG).

A Threatened species is one that has been published as such by the U. S. Fish and Wildlife Service in a final rule in the Federal Register. An Endangered species is one that has been published as such by the U. S. Fish and Wildlife Service in a final rule in the Federal Register. A Proposed species is one for which listing has been proposed in a proposed rule in the Federal Register (USDA Forest Service 2005).

A Candidate species is one given that designation by the U. S. Fish and Wildlife Service in the Federal Register. Candidate species have no protection under the Endangered Species Act, but in the Rocky Mountain Region Candidate species are automatically considered as Sensitive species (USDA Forest Service 2013).

A Sensitive species is one that has been identified as such by the USDA Forest Service's Rocky Mountain Region in a recent supplement to the Forest Service Manual – the most recent supplement is one effective August 29, 2015 (USDA Forest Service 2015a, USDA Forest Service 2015b).

PROPOSED ACTION AND ALTERNATIVES TO IT

Alternative 1 (No Action Alternative)

The National Environmental Policy Act (NEPA) requires the study of the No Action Alternative and directs that this alternative be used as a basis for comparing the effects of the Proposed Action and other alternatives.

The No Action Alternative assumes that no implementation of the proposed action or the other action alternative would take place within the project area. This alternative represents no attempt to actively respond to the issues, purpose and need for action, or concerns identified during public scoping for this project. There would be no effort to modify existing conditions, unless authorized by other decisions. Other management actions including vegetation management projects are authorized and would likely continue to be authorized within the project area and timeframes analyzed in this EIS. These other projects would proceed under separate NEPA analyses. Other related projects which are currently authorized are noted in Chapter 1 under "Other Related Efforts."

ACTIVITIES COMMON TO ALL ACTION ALTERNATIVES

The following sections provide additional information regarding activities common to all action alternatives.

Scope and Scale of Treatments

On the GMUG, approximately 223,000 cumulative acres have experienced spruce beetle mortality and 229,000 acres have experienced Sudden Aspen Decline. Due to budget constraints, the scale of the epidemic, and the magnitude of affected and potentially affected acres across all terrain of the forest, the Forest Service cannot treat all affected acres. Although landscapes of various extent are analyzed in this EIS to afford flexibility for land managers to respond in real-time to rapidly changing forest conditions, the Forest is proposing and analyzing treatments of a maximum of 120,000 acres, or 4% of the GMUG, in equal proportions between commercial and noncommercial treatments. These treatments would be implemented over an approximately 8-12 year implementation span. Annual acres treated are limited by personnel and budget constraints in the Forest Service.

All commercial treatment would occur on lands identified as suitable for timber production as defined by the Forest Plan (GMUG Forest Plan Amendment, 1991, pages F-1-F-7). Spruce-fir and spruce-aspen mix are considered for commercial treatment. At the time of the analysis, there is no existing market for aspen; unless a market were to emerge during the implementation timeframe of this project, commercial treatments in aspen would not be likely to occur. In order to commercially treat aspen areas analyzed in SBEADMR, the GMUG would need to determine that this NEPA document sufficiently disclosed the effects of such treatments

Priority Treatment Areas Defined

Priority treatment areas (PTAs) in SBEADMR are the maximum extent of geographic area analyzed for potential treatments. Starting with the original opportunity areas within the Draft EIS, the GMUG and CSU Science Team developed a comprehensive spatial modeling process to bring focus and prioritization to the project. After optimizing for a variety of resource and operational variables, each PTA was validated by GMUG specialists with professional knowledge of the ground (See Appendix F for further detail). Whereas the project area ranged from 300,000-718,000 acres in the Draft EIS, the sum total of the PTAs, potential roadside hazard trees, and additional road construction in the Final EIS now range from 127,000 acres to 208,000 acres.

As in the Draft EIS, a *subset* of the analysis area (PTAs) for Alternative 2 would be treated over the life of the SBEADMR project. Only 60,000 acres of commercial treatment would occur, and only 60,000 acres of noncommercial treatment would occur. The GMUG intentionally selected PTAs that total approximately 2-3x the extent of actual treatments in order to monitor and adapt the treatment type and location to the changing forest conditions. However, once the IDT took into account the other vegetation types within the *noncommercial* PTAs – non-target vegetation that wouldn't be treated—the total noncommercial PTA acres dropped to 77,000 acres. Therefore, approximately 1 out of every 1.3 acres analyzed for noncommercial treatment in Alt 2 would be completed. In contrast, in Alternative 3, the PTAs are limited to the WUI, and this considerably reduced the total analysis area. Unlike Alternative 2, in which a subset of PTAs would be treated, each PTA in Alternative 3 would be treated.

As noted in the Draft EIS, the original opportunity areas—and hence, the PTAs—are limited to spruce and aspen forest types outside of Wilderness, Research Natural Areas, Special Interest Areas, Cultural Areas, and National Natural Landmarks. Additionally, Colorado Roadless Areas (CRAs) are not included, as the limited agency capacity will be applied most effectively to conduct active management treatments to less controversial areas. Treatments in CRAs would be proposed and authorized under separate NEPA processes.

Adaptive Implementation & Continued Public Involvement

The Forest Service cannot significantly alter the current infestation or rate of decline in spruce stands, but management of associated hazards, economic opportunities, and resilience, as detailed in the purpose and need, are the core of this project. Nor can it accurately project the ultimate location and scale of eventual beetle activity. To achieve the purpose and need in the context of rapidly changing conditions in spruce and aspen stands across the landscape, SBEADMR relies on an adaptive implementation framework to prioritize the sequence and determine precise layout of successive treatments within the analyzed PTAs. Treatment design, incorporating additional monitoring questions, reviewing the effects of previous treatments, and adjusting management towards desired conditions and away from undesirable conditions would also be conducted via the adaptive implementation approach. At 36 C.F.R. § 220.3 (2010), adaptive management is defined as "a system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that will best ensure that those outcomes are met or re-evaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain". Specific decision-making triggers for adaptive implementation are identified in Table 1, below. Some triggers related to meeting desired conditions, and other pertain to maintaining impacts within established legal and/or project limits.

Public involvement is critical throughout implementation, and is explicitly incorporated into the approach, as detailed below and in *Appendix E.*

The adaptive implementation and monitoring framework defines a) a cycle of checkpoints and b) an associated toolbox, discussed in further detail below.

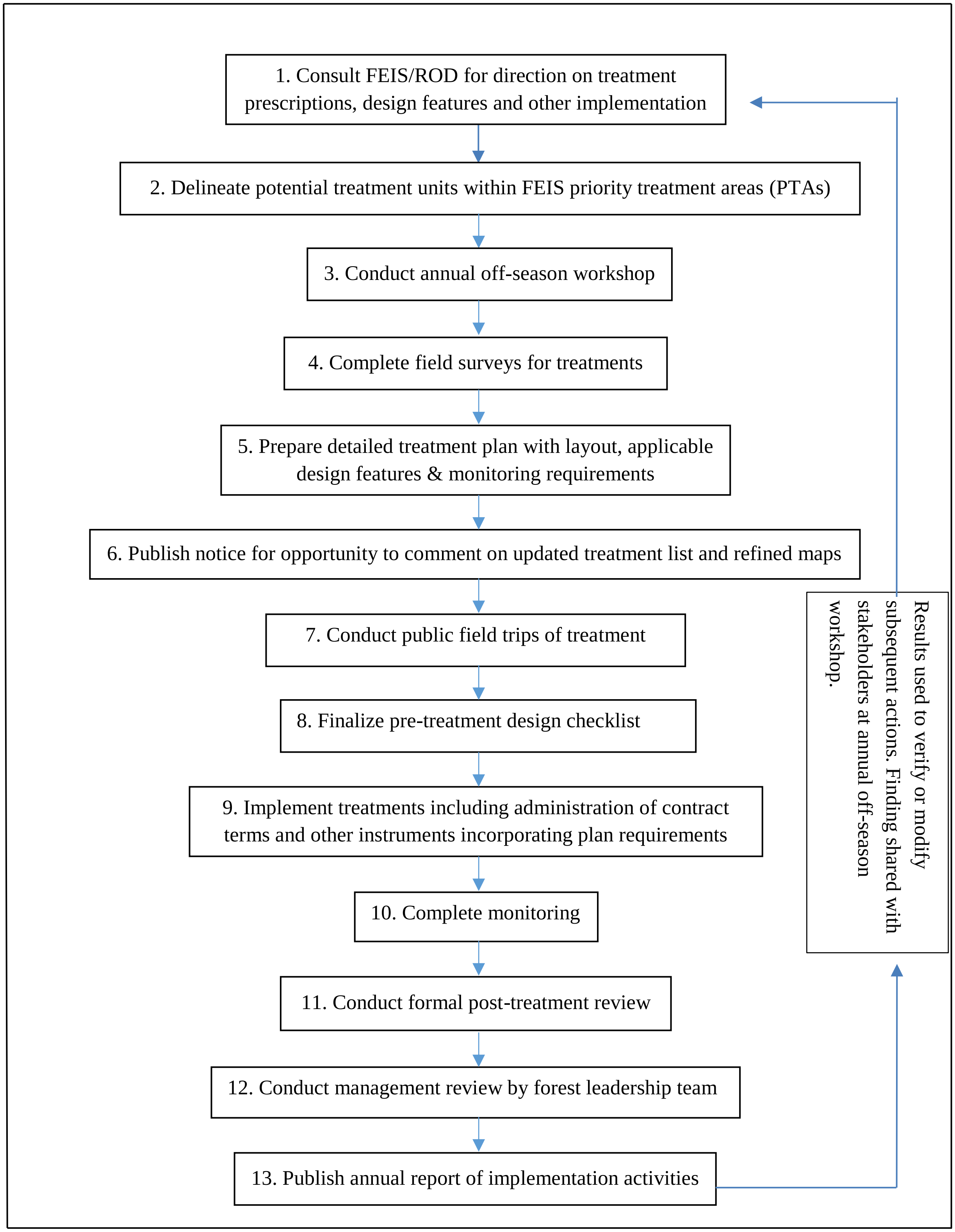

Figure 1. Adaptive implementation and monitoring framework for SBEADMR

Checkpoints

The checkpoints in the adaptive implementation cycle would involve public stakeholders, a science team, and Forest staff. Figure 1 indicates how stakeholders, the Forest Service, and the Science Team will work together to complete all five parts of the Adaptive Implementation & Public Involvement Framework.

Checkpoints for the adaptive implementation will include five major components:

1) Public notice and comment on annual basis for upcoming cycle of treatments;
2) Pre-Implementation treatment planning;
3) Post-Treatment implementation review focusing on design feature compliance;
4) Annual monitoring review/evaluation and new science summary with stakeholders and science team;
5) Annual Management Review.

The GMUG recognizes that a landscape-scale project analysis such as SBEADMR is difficult for the public to comment on and to be assured that effects are adequately disclosed. Due to the adaptive nature of the proposal and in response to public comments on the Draft EIS, the GMUG will annually provide public notice and opportunity to comment on the upcoming specific set of SBEADMR treatments. Public comments will assist GMUG staff in determining the adequacy of the original effects analysis and of the original project components for each successive set of treatments.

Opportunities for stakeholders to influence implementation would be confined by the sideboards of the selected alternative, as outlined in the Final Record of Decision (ROD) and Environmental Impact Statement (EIS). Further, the Forest Service retains the authority to make final decisions related to location, extent and types of treatments planned and completed consistent with the ROD/EIS. However, if at any-time stakeholders have specific questions or concerns related to any aspect of implementation under SBEADMR, Forest staff would be responsive and take steps to accommodate stakeholder input to the greatest extent practicable. The process outlined here would be required by the ROD. See *Appendix E* for further detail.

Implementation Toolbox

The implementation toolbox defines the range of silvicultural and fire prescriptions and design features for treatment implementation and provides a mechanism for monitoring and documenting compliance. These tools would be used throughout the adaptive implementation cycle outlined above. The prescriptions and design features are incorporated into both action alternatives and effects analyses; however, the application of an individual prescription and a suite of design features will depend upon on-the-ground conditions at the time of implementation. These conditions, or triggers for use, are defined in Chapter 3, resource sections.

Most tools are detailed further in an associated referenced appendix. Tools include:

- Triggers for Adaptive Implementation – In response to public comments, decision-making triggers from the Draft EIS are explicitly identified in one table in the Final EIS. See *Table 1. Decision-Making Triggers for Adaptive Implementation in SBEADMR.*

- Silvicultural Prescription Matrix – would be used to identify which and how various stands will be treated to achieve management objectives. Detailed silvicultural prescriptions will be completed by a certified silviculturist by comparing current versus desired vegetative conditions. *See Appendix A.*

- Design Features – would be applied to treatments to minimize or avoid undesirable impacts to resources including, but not limited to, vegetation, soils, water, wildlife and cultural resources. Design Features are incorporated into both action alternatives and their effects analyses. The appropriate design features would be applied when surveys or management activities indicate a need to do so. It is also assumed that design features will be implemented as designed and in a readily visible way, effective. Analysis completed in this document assumes implementation of the appropriate design features *See Appendix B.*
- Pre-Treatment Checklist – tracking tool would document that all required surveys and compliance checks for an individual treatment have been completed. The checklist will also identify design features that would be applied to a particular treatment. For example, the presence of a Northern goshawk nest in a treatment area would trigger the avoidance/protective measures as specified in the design features of the EIS. As such, the checklist would assure treatments are implemented consistent with the EIS. The checklist will also be used to confirm compliance with the Forest Plan. *See Appendix C.*
- Annual Interdisciplinary & Management Review – a monitoring method that provides documentation that treatments are implemented as planned. The IDT review, combined with monitoring results and science team input, would provide feedback to forest managers about how to best design and implement future treatments in the treatment area. The results of this monitoring, in conjunction with best available science, will identify relevant improvements to procedures or exemplary practices to benefit future treatments authorized by the SBEADMR record of decision. *See Appendix D.*
- Public Engagement in Adaptive Implementation -- the phases, principles, and activities of public engagement throughout the life of the SBEADMR project. The primary goal is to engage diverse groups and individuals so that they might identify common problems, interests, and potential solutions. *See Appendix E.*

NEPA Sufficiency

In some cases, changed conditions may bring into question whether the scope and range of effects disclosed in this analysis are exceeded. Typically, a change in a design feature to render it more effective to protect resource values or to achieve desired outcomes would remain within the scope and range of the effects analysis. Elimination of a design feature intended to minimize effects would likely be outside the range and scope of the analysis. A change in assumptions analyzed in the EIS could also trigger a NEPA sufficiency review. For example, it was assumed that the level of impact to habitat supporting Canada lynx would stay within Forest-level caps identified in the Southern Rockies Lynx Amendment (SRLA). These caps would be tracked over the life of the project, and if tracking indicates a pending exceedance in any given year, no additional treatment would be permitted until additional NEPA and additional consultation with Fish and Wildlife Service was completed. Substantive changes would require the Forest to undertake an interdisciplinary review of the sufficiency of the NEPA documentation prepared for this treatment.

As noted above, public notice and comment period on an annual basis for out-year treatments will serve an important role to determine the continued sufficiency of this NEPA document.

During sufficiency reviews, the GMUG may determine the information in the original decision is still valid and is not in need of correction or supplement. However, if that review reveals a need for a correction, supplement or revision to the original decision, then the specific process to correct, supplement, or revise the analysis would be used, as specified in FSH 1909.15(18.2).

Table 1. Decision-Making Triggers for Adaptive Implementation in SBEADMR. Red light triggers correspond with a legal standard/project standard that cannot be crossed, whereas a yellow-light trigger indicates that a resource is being affected negatively, signaling the need for increased mitigation of effects, a change in management approach, or slowing of the pace of implementation (Schultz & Nie, 2012).

Desired Condition	**Indicator(s)**	**Unit of Measure**	**Methods**	**Scale**	**Frequency**	**Yellow Light Trigger**	**Adaptive Action**	**Red Light Trigger**	**Adaptive Action**	**Regulatory Requirement**
Management of the Treatment for: Vegetation, Wildlife, Visuals Objectives										
Maintain structural diversity of vegetation at the watershed scale (diversity unit - 6th HUC).	5-15% or more of vegetation at 6th field watershed unit is in an old growth forest classification, where biologically feasible.	Habitat structural stages 4A, 4B and 4C.	Prior to treatment planning, determine the amount of live 4A, 4B and 4C in watershed.	Diversity unit - 6th field HUC	During treatment planning OR complete quick assessment at the watershed scale prior to treatment planning.	Amount of habitat structural stages 4A, 4B, 4C pre-treatment is less than 20%.	**Limited overstory mortality** Plan treatments to ensure minimum old forest classifications are maintained. **High overstory mortality** - retain pockets of live habitat structural stages 4A, 4B and 4C to the greatest extent practicable.	Amount of habitat structural stage 4A, 4B and 4C pre-treatment is less than 5%.	Same as yellow.	**LRMP**
Maintain soil productivity, minimize human-caused erosion and maintain integrity of associated ecosystems (III-73 01a)	Past activities and proposed activities would contribute to a combined detrimental soil disturbance that is above or approaching the 15% threshold of a treatment unit.	Percent of detrimental soil disturbance within a treatment unit (DSD includes: compaction, rutting, burn severity, displacement, surface erosion and mass movement).	Implement Design Features WQSP-4, 5A, 5B, and 7B in accordance with requirements of the treatment design checklist. Spot check treatment units using accepted soil monitoring protocols.	Treatment	Pre-treatment checklist and, as triggered, post-treatment monitoring	Pre-treatment review in FACTS confirms past ground-based activities in proposed treatment area.	Complete pre-treatment survey to determine detrimental soil disturbance percentage. Work with IDT to design treatment to maintain the cumulative detrimental effects from project implementation and rehabilitation should not exceed the conditions prior to the planned activity and should move toward a net improvement in	Upon completion of pre-Tx survey and considering net impact of proposed treatment, it is determined that net detrimental soil disturbance post-treatment would exceed 15% of the activity area.	Modify treatment boundaries and/or exclude this treatment until further soil restoration activities completed.	LRMP

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
							soil quality.			
Eliminate/minimize soil damage from machine pile burning	Bare soil, rilling, gullying, and soil movement within machine pile burn scars	Percent of machine pile burn scars, and area within each burn scar, without vegetation or showing signs of rilling, gullying, or soil movement.	Monitor a sample of pile burn scars for bare soil and--on scars located on slopes and in swales--for the presence of rills, gullying, or soil movement.	Treatment	Within 3 years of pile burning	>100 sq ft of burn scar consisting of bare soil; minor rilling or gullying present within or adjacent to burn scar; minor deposition of soil downslope of scar.	Treatment of bare soil and erosion according to District protocols, may include one or two of the following: addition of mulching, scarification, inoculation with adjacent soils, seeding, etc.	>200 sq ft of burn scar consisting of bare soil; multiple rills, or gullying, or gullying 2-3" deep within burn scar; significant deposition of soil downslope of scar.	Treatment of bare soil according to District protocols, may include several or all of the following: addition of mulching, scarification, inoculation with adjacent soils, seeding, etc.	
Lynx-Specific Management										
<30% of lynx habitat in an LAU in a stand initiation structural stage/ silviculturally treated to remove cover for snowshoe hare and does not yet provide winter snowshoe hare habitat. SRLA Standard VEG S1.	Harvest, road construction or other anthropogenic or natural disturbances within lynx habitat.	Acres per LAU	Track acres of management actions and/or natural disturbances reported in FACTS or INFRA (Forest Service databases). To ensure compliance with design Feature WFRP-16.	Lynx Analysis Unit	Annual	25% of lynx habitat in LAU in a stand initiation structural stage (SISS) condition.	Discontinue or reduce acres of treatment in suitable lynx habitat. Stands with extensive over-story morality (>90%) that lack an understory can continue to be treated since they are already considered unsuitable via SRLA. Plan any future actions so 30% threshold is not exceeded.	Fire or spruce beetle results in widespread loss of the understory, leaving >30% percent of the LAU in a stand initiation structural stage.	Discontinue treatments in suitable lynx habitat. Stands with extensive over-story morality (>90%) that lack an understory can continue to be treated since they are already considered unsuitable via SRLA.	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.
<15% of lynx habitat in an LAU would be regenerated by vegetation management (over 10-year period beginning in 2009). SRLA Standard VEG S2.	Vegetation managementth at regenerates stands.	Acres treated over 10-year period in LAU	Management actions reported in FACTS. Even-aged treatments - entire stand.	Lynx Analysis Unit	Annual	Vegetation management has regenerated 10% of lynx habitat in LAU. Fuel treatments are exempt from the trigger.	Discontinue or reduce acres of treatment to ensure new (outyear) proposed treatment areas do not exceed the 15% threshold in the	Vegetation management has regenerated 15% of lynx habitat in LAU. Fuel treatments are exempt from the trigger.	Discontinue treatments in suitable lynx habitat. Stands with extensive over-story morality (>90%) that lack an understory can continue to be treated since	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
							LAU.		they are already considered unsuitable via SRLA.	
<3% of lynx habitat on the Forest will be thinned. Precommercial thinning and similar practices intended to reduce seedling/sapling density limited to: 200 feet of structures; research studies; conifer removal in aspen.	Actions with intent to reduce seedling/saplin g density.	Acres treated	Management actions reported in FACTS	Forest-wide	Annual	2.5% of Forest thinned.	Plan acres of outyear treatments such that they do not exceed the 3% Forest-wide cap.	3% of Forest thinned	Discontinue pre-commercial thinning to ensure forest-wide cap is not exceeded. If additional thinning is needed to accomplish resource objectives, reinitiate consultation as required by the SRLA.	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.
Watershed Management										
To ensure HUC12 disturbance is less than 25 percent, maintain disturbances from mechanical harvest treatments and roads to less than 25 percent of the HUC12 area. Other natural events (wildfire) could also affect watershed integrity and will be tracked when they occur.	Weighted[1] acres of mechanical harvest, road construction or other anthropogenic or natural disturbances within the watershed.	Acres per HUC12 watershed	Track acres of management actions and/or natural disturbances reported in FACTS or INFRA (Forest Service databases). To ensure compliance with design Feature WQSP-10.	HUC 12 Watershed	Pre-treatment checklist item	20% of HUC 12 affected.	Discontinue or reduce acres of treatment in watershed so 25% threshold not exceeded.	Wildfire and cumulative management activities result in 25% of HUC12 affected.	Discontinue treatments in suitable watershed until recovery has occurred.	LRMP, Watershed Conservation Practices Handbook.

[1] *See Appendix I, Watershed Cumulative Effects Analysis for explanation of weighting process.*

Treatments

Resiliency in the Context of Vegetation Management

Resilience is the capacity of a system to tolerate disturbance without shifting to a qualitatively different state that is controlled by a different set of processes (Resilience Alliance 2012); i.e., the ability of a system to retain its function, structure, identity and feedbacks in the face of disturbance and environmental change (Walker et al. 2004).

A resilient forest ecosystem is a forest that contains the diversity of composition, size, density and pattern that enables it to cope with changing disturbance processes**.** Such an ecosystem is capable of providing various ecosystem services such as wildlife and aquatic habitat for a variety of species, clean water, recreation, and carbon sequestration in the short and long term.

Spruce Recovery and Resiliency

The spruce recovery goals would be met via removal of dead and dying trees (salvage) followed by regeneration from on-site seed sources, re-sprouting of aspen, or tree planting where adequate natural seed sources are lacking. As detailed in the silvicultural prescription matrix (*Appendix A*), recovery treatments would be designed to retain advanced regeneration and green trees to the maximum possible extent.

Resiliency goals in spruce stands would be met by removal of single trees or group selections of trees where bark beetle impacts are light or in areas yet unaffected by beetles. Resiliency treatments are designed to mimic natural gap dynamics that maintain or encourage multi-storied attributes, with the same considerations for retention of advanced regeneration as noted above. These treatments would be completed in accordance with the Southern Rockies Lynx Amendment, and they are considered a conservation measure for lynx (USDA Forest Service 2008, SRLA). Cuts typically cover only 20-40% of a given treatment unit.

Aspen Resiliency

Aspen and aspen-spruce treatments would consist of coppice cutting, mastication, prescribed fire or removal of single spruce or groups of spruce within a stand dominated by aspen. The treatment goal is to regenerate or maintain aspen; site disturbance through treatment activities and removal of aspen canopies typically stimulates regeneration of aspen from the existing root system. Efforts would be made to prioritize treatments based upon likelihood of aspen persistence, given climate projections and current modeled future distribution by elevation (Rehfeldt et al. 2015).

Adapted Future Action

As a green spruce stand becomes increasingly affected by spruce beetle, the appropriate treatment would trend from an initial planned resiliency prescription to a salvage operation. Because of this changing condition in spruce stands and the corresponding change in the type of appropriate silvicultural prescription, the FEIS explicitly notes the acres of treatment type based on forest conditions as detected today and also projects the acres of potential treatment type (all salvage) based on the maximum potential extent of the spruce beetle epidemic within the project area. Although unlikely that spruce beetle would extend to the entirety of the stands analyzed in the SBEADMR project area, the current condition and this maximum potential extent of a future diseased condition provided bounds for specialists to analyze the effects of treatment given a) current and b) changed conditions.

With respect to aspen, the changing stand condition does not precipitate such a difference in silvicultural application. Rather, when stands exceed 50% overstory mortality, research indicates that regeneration treatments are less successful. If prior to treatment application, overstory mortality were to exceed that threshold for a given stand analyzed in the SBEADMR project area, instead of modifying the prescription, the Forest Service would likely not attempt implementation. Therefore, the bounds of effects analysis for aspen range between the effects of the No Action alternative and the effects of the action alternatives.

Hazard Tree Treatments

Roadside corridors are identified and analyzed in the FEIS for *potential* hazard tree removal. It is important to note that roadside treatments, unless analyzed as part of a PTA, would be limited to the hazard trees. The roadside corridor is limited as follows:

- Where slopes are >40%: 300 foot buffer from both sides of the road (600 feet total buffer)
- Where slopes are <40%: 150 foot buffer from both sides of the road (the average tree height plus 20%; 300 feet total buffer)

Mechanical Treatments

- Commercial treatments would occur in lands identified as suitable for timber production by the GMUG 1991 Forest Plan Amendment (USDA Forest Service, 1991, Appendix F).
- Non-commercial mechanical treatment methods would include mastication of understory conifer utilizing vertical or horizontal shaft masticators, hand or machine cutting of understory conifer followed by lop and scatter of the slash, hand or machine cutting of understory conifer followed by piling/burning of slash, mastication of aspen as a coppice treatment, and hand or machine cutting of aspen followed by either lop and scatter or piling/burning of the slash as a coppice treatment. Mechanical treatment on slopes greater than 40% would be limited to chainsaws.
- Most tree removal would be accomplished using a variety of contracting methods including commercial timber harvest, service contracts, and stewardship contracts. To a lesser extent, Forest Service work crews or cooperators would be used to thin trees and reduce fuels in areas where contracting is not feasible.

- All commercial mechanical treatments and non-commercial mechanical treatments involving large equipment would occur on slopes less than 40%. For slopes greater than 40%, mechanical treatments would be limited to chainsaws.
- Openings from mechanical treatments in beetle-infected spruce stands or dying aspen stands may exceed 40 acres. Per the 1991 GMUG Amended Forest Plan, the maximum size of openings creating by the application of even-aged silviculture is 40 acres (p. III-43); however, larger openings are permitted in the event of natural catastrophic conditions, such as insect or disease attack. Per the National Forest Management Act, Forest Plan maximum size for openings to be cut in one harvest operation shall not apply to the size of openings harvested as a result of natural catastrophic conditions such as fire, insect and disease attack, or windstorm (16 U.S.C. 1604(g)(3)(F)(iv)).
- Non-commercial mechanical treatments in stands dominated by aspen but having an spruce-fir component mapped as lynx habitat will be limited as follows: within secondary lynx habitat (defined as within 300 meters or 984 feet of primary habitat), removal of spruce-fir in mixed Aspen-spruce stands will not occur. Primary habitats are stands composed of primarily spruce-fir that support habitat elements necessary to support lynx or their prey.
- Within critical habitat for Gunnison sage-grouse, sagebrush will be avoided when conducting non-commercial treatments.
- Precommercial thinning in live multi-story mature or late successional conifer forests will be subject to the Southern Rockies Lynx Amendment, Standard VEG S6 – Exceptions 1, 3 and 4 and VEG S5 Exception 1 and 3.

Prescribed Fire Treatments

- Prescribed fire treatments include broadcast burning and pile burning.
- Broadcast burning would be accomplished with aerial or hand ignitions. Individual burn units would range in size from as small as 50 acres to more than 5,000 acres.
- Most broadcast burning would be applied in areas with an aspen component. Some broadcast burning may be applied in salvaged single-story spruce stands where little/no regeneration is present in order to reduce slash fuel loadings and as a pre-planting site preparation measure.
- Pile burning would be conducted in conjunction with other, mechanical treatments to remove excess fuels created by the treatment. Piles would be either created at landings or constructed throughout treatment units.
- Any treatments that have prescribed fire as a component, whether broadcast or pile burning, will have a Burn Plan developed for them. Burn Plans are required by agency policy and are guided by the FS Manual 5140 as well as the Interagency Prescribed Fire Planning and Implementation Procedures Guide (April 2014). Burn Plans are approved by the Agency Administrator (Forest Supervisor or District Ranger) and contain

treatment-specific requirements regarding fuels, topography, and weather conditions under which the burn can be ignited, as well as required fire behavior to meet both the desired objectives and to maintain control of the burn. Burn Plans also contain burn objectives, complexity analysis, size and type of management organization, contingency plans, safety issues and associated mitigations, ignition and holding plans, and smoke management considerations. Additionally, a Smoke Permit from the State of Colorado, Department of Environmental Health, Air Pollution Control Division, would be obtained for any prescribed burn. The Smoke Permit contains 'permit conditions' under which the burn must be ignited; these include maximum daily acres, wind direction, dispersion index, daily ignition cutoff times, and mitigation measures related to smoke management.

- Within critical habitat for Gunnison sage-grouse, sagebrush will be avoided when conducting prescribed fire.

Access

The existing road network would be used to the maximum extent possible to access the proposed treatments and to remove forest products. For commercial treatments, existing roads would be supplemented by constructing new temporary roads only when necessary; criteria are indicated below. No road construction is proposed for noncommercial treatments. Where necessary for resource protection, existing roads would be reconstructed. Per Forest direction, there would be no increase in open road density.

Road Maintenance

National Forest System roads being used for the project that are in functioning condition would be maintained during the project implementation. Maintenance preserves the function of the road but generally does not include improvements. Maintenance activities generally include: blading; brushing; removal of roadside hazard trees; repair and/or replacement of road surfaces; cleaning, repair, or installation of drainage structures such as culverts, ditches, and dips; dust abatement; removal and installation of closure barriers, and installation or repair of signs. Maintenance activities generally do not disturb ground outside the existing roadway (toe of fill to top of cut) other than removal of material around culvert inlets and cleaning of outlet ditches.

Road Reconstruction

Reconstruction generally includes work to improve and restore roads, or to bring them back up to the original design standard. Improvements would provide for serviceability for project haul vehicles, as well as for proper hydrologic function and stream protection in accordance with applicable Best Management Practices. Actions can include surface improvement; construction of drainage dips, culverts, riprap fills or other drainage or stabilization features with potential disturbance outside the established roadway (toe of fill to top of cut); realignment; and widening of curves as needed for log trucks and chip van passage. Reconstruction also includes the actions included in the Maintenance category, including removal of roadside hazard trees.

Reconstruction includes the replacement of unsustainable existing roads with new, designed roads, as well as decommissioning of the prior unsustainable road.

Road Construction

New road construction alignments to access priority treatment areas have been developed. For the Final EIS, the GMUG developed a proposed road system using the following criteria:

- Skid distances from PTAs were greater than ¼ mile to an existing road

Expected actions for road construction include vegetation clearing, excavation and/or embankment, blading and shaping, out-sloping, drainage dips, and water-spreading ditches, and may include importing of armoring and surfacing rock material as needed. More embankment and drainage structures would be utilized when there are adjacent resource concerns (perennial and intermittent stream crossings, high soil erosion hazard, steeper side slopes, etc.). Note that because all new roads in the action alternatives would be decommissioned within 5 years of the closure of the associated SBEADMR timber sale, all road construction analyzed in SBEADMR is temporary.

Road Decommissioning

In response to public comments on the Draft EIS, all roads constructed for SBEADMR will be decommissioned within 5 years of the close of the associated commercial sale. Retention of any SBEADMR road in the National Forest System would require an additional, separate project-level NEPA analysis and decision, and must be informed by a travel analysis process.

Furthermore, existing roads used for project implementation that are *not* identified as National Forest System roads would also be decommissioned within 5 years of the close of the associated commercial sale.

Decommissioning involves a combination of the following rehabilitation tools: removing bridges and culverts, eliminating ditches, out-sloping the roadbed, ripping and scarifying of the road surface to reduce compaction and promote native vegetation, reseeding/replanting native vegetation, removing ruts and berms, effectively blocking the road to normal vehicular traffic where feasible under existing terrain conditions, and building cross ditches and water bars. When bridges and culverts are removed, associated fills shall also be removed to the extent necessary to permit normal maximum flow of water and reconstruction of the floodplain and stream channel as needed.

Right-of-way Acquisition

SBEADMR's identified system of existing haul roads for commercial treatments anticipates a limited number of roads under private jurisdiction would provide more efficient access to a commercial treatment. These account for <1% of anticipated haul routes. These roads would require a Forest Service right-of-way or access agreement to allow for access and haul of forest products. Where appropriate, public easements would be pursued; at a minimum, administrative access would be needed for treatment implementation.

Other Public Roads

Vegetation treatments along and adjacent to county- and State-managed public roads are included in the action alternatives. Where SBEADMR implementation efforts could potentially interfere with traffic or operations of these public roads, coordination with the applicable agency is necessary. This includes construction of new intersections and access aprons that would tie into existing public roads. Coordination would address signing and traffic control, permitting, alignment, and construction standards necessary for new aprons and intersections, at a minimum.

Connected Actions Related to Roads

Available water and rock material sources within and adjacent to the treatment area would be utilized to support road work. Roads providing access to and from these sites would also be maintained and reconstructed when applicable.

Alternative 2 (Agency Preferred Action)

Size and Geographic Location of Treatments

Alternative 2 analyzes 207,615 acres of discrete disturbance acres. 190,014 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 17,388 acres as potential hazard tree treatments outside of PTAs, and 213 acres are for potential new road disturbance outside of PTAs. Of the PTA acres, approximately 59% (112,768 acres) are identified as commercially suitable timber acres, and 41% (77,246 acres) are identified for noncommercial treatment. See Table 2, Table 3, and Table 4. Maps of Alternative 2 are located in Appendix G (Maps G-1 to G-18).

As noted in *Activities Common to All Alternatives*, maximum commercial treatments would total 60,000 acres and maximum noncommercial treatments would total another 60,000 acres, for a total of 120,000 maximum treated acres. Therefore, for commercial treatments, approximately 1 of every 2 acres analyzed for commercial treatment in this alternative would be treated. For noncommercial, approximately 1 of every 1.3 acres analyzed for noncommercial treatment would be treated.

Table 2. Alternative 2: Summary of Analysis Acres

Proposed Activity	**Total Acres**
Hazard Trees Outside PTAs	17,388
New Roads Outside PTAs	213
Priority Treatment Areas	190,014
Commercial	*112,768*
Noncommercial	*77,246*
Grand Total Analysis Acres	**207,615**

Table 3. Alternative 2: Summary of Analysis Acres by Geographic Area & Activity Type.

The Adapted Future Action -All Salvage treatment type is identified in order to provide bounds for analysis. Proposed broad treatment types are based on the current level of mortalities in a stand, but as mortality from spruce beetle increases, more treatments would correspondingly shift to salvage.

	Outside PTAs		*Commercial PTA & Treatment Type*					*Noncommercial PTA & Tx Type*			
Geographic Area	**Hazard Trees**	**New Roads**	**Combination**	**Resiliency**	**Salvage**	**Adapted Future Action -All Salvage**	**Total Commercial PTA**	**Burn & Mechanical**	**Mechanical Only**	**Total Noncomm PTA**	**TOTALS by GA**
Grand Mesa	1,075	19	8,808	6,163	486	*15,457*	**15,457**	14,548	830	**15,378**	**31,929**
Gunnison Basin North	3,696	49	6,897	6,663	1,825	*15,385*	**15,385**	21,560	0	**21,560**	**40,691**
Gunnison Basin South	4,794	44	11,334	4,419	12,061	*27,815*	**27,815**	7,954	0	**7,954**	**40,607**
North Fork Valley	2,258	25	3,356	5,025	544	*8,925*	**8,925**	7,176	864	**8,039**	**19,247**
San Juans	2,023	42	7,773	2,595	1,830	*12,198*	**12,198**	348	0	**348**	**14,611**
Uncompahgre Plateau	3,542	34	14,997	17,634	357	*32,988*	**32,988**	23,966	0	**23,966**	**60,531**
TREATMENT TOTALS	**17,388**	**213**	**53,166**	**42,499**	**17,103**	***112,768***	**112,768**	**75,552**	**1,694**	**77,246**	**207,615**

Table 4. Alternative 2: Cover Type by PTA Treatment Category

Treatment Category	Cover Type	Acres	% of Row Total
Commercial		**112,768**	**59%**
	Aspen	4,950	4%
	Aspen Spruce Mix	37,038	33%
	*Other**	*2,660*	*2%*
	Spruce	68,121	60%
Noncommercial		**77,246**	**41%**
	Aspen	69,114	89%
	Aspen Spruce Mix	8,132	11%
Grand Total PTA Acres		**190,014**	**100%**

**Other* cover types within the commercial Priority Treatment Areas would not be treated.

** In addition to the vegetation cover types targeted for noncommercial treatment listed here (aspen and aspen-spruce mix), other cover types in the noncommercial Priority Treatment Areas could be incidentally treated in order to facilitate implementation of prescribed burns in the targets. Approximately 6,257 acres are identified in detail and analyzed for treatment in the Fuels section, Chapter 3.

Silvicultural Prescriptions

The full suite of identified silvicultural prescriptions are included in Alternative 2. See Appendix A.

Access

In order to access proposed commercial treatments and remove forest products, Alternative 2 includes the following maximum roadwork. These represent maximum anticipated miles that may be constructed and maintained under this alternative, and are based on the maximum acreage analyzed for commercial treatment in Alternative 2. This roadwork would be conducted in accordance with the descriptions provided above (See *Activities Common to All Action Alternatives / Access).*

Table5. Alternative 2 Maximum Road Treatments

	No Action	Alt 2
Road construction (miles)	0	178
Road reconstruction (miles)	0	538
*Existing system roads**	*0*	*356*
Existing non-system roads	*0*	*182*

Road decommissioning	0	360
Road maintenance (miles)*	0	714

**Assumed that 1/3 of system roads used for hauling would be reconstructed prior to use and the remaining 2/3 would simply be maintained.*

Alternative 3 (WUI Alternative)

Alternative 3 shifts the geographic extent of treatments exclusively to 1) the wildland urban interface (WUI) and 2) outside the WUI, proximal to additional human infrastructure.

All treatment types and methods would remain the same as in Alternative 2, but would be limited to the identified geographic extent.

Size and Geographic Location of Treatments

Alternative 3 analyzes 127,023 acres of discrete disturbance acres. 102,159 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 24,695 acres as potential hazard tree treatments outside of PTAs, and 169 acres are for potential new road disturbance outside of PTAs. Of the PTA acres, approximately 45% (45,967) are identified as commercially suitable timber acres, and 55% (56,192) are identified for noncommercial treatment. See Table 6, Table 7, and Table 8. Both noncommercial and commercial PTAs in Alternative 3 total less than 60,000 acres, so treatments of hazard trees may or may not make up the difference. Depending on the extent of hazard trees within the identified roadside corridors over the life of the project, fewer total acres may be treated in Alternative 3, ranging from ~46,000-60,000 acres commercially to 56,192-60,000 acres noncommercially. Maps of Alternative 3 are located in Appendix G (Maps G-18 to G-36).

As noted in *Activities Common to All Alternatives*, maximum commercial treatments would total 60,000 acres and maximum noncommercial treatments would total another 60,000 acres, for a total of 120,000 maximum treated acres.

Table 6. Alternative 3: Summary of Analysis Acres

Proposed Activity	Total Acres
Hazard Trees Outside PTAs	24,695
New Roads Outside PTAs	169
Priority Treatment Areas	102,159
Commercial	*45,967*
Noncommercial	*56,192*
Grand Total Analysis Acres	**127,023**

Table 7. Alternative 3: Summary of Analysis Acres by Geographic Area & Activity Type.

The Adapted Future Action -All Salvage treatment type is identified in order to provide bounds for analysis. Proposed broad treatment types are based on the current level of mortalities in a stand, but as mortality from spruce beetle increases, more treatments would correspondingly shift to salvage.

			Commercial PTA & Treatment Type					*Noncommercial PTA & Tx Type*			
Geographic Area	**Hazard Trees Outside PTAs**	**New Roads Outside PTAs**	**Combination**	**Resiliency**	**Salvage**	**Adapted Future Action - All Salvage**	**Total Commercial PTA**	**Burn & Mechanical**	**Mechanical Only**	**Total Noncomm PTA**	**TOTALS by GA**
Grand Mesa	1,516	28	5,283	3,605	376	*9,264*	**9,264**	11,809	830	**12,639**	**23,448**
Gunnison Basin North	5,241	45	1,986	2,245	732	*4,963*	**4,963**	15,173	0	**15,173**	**25,421**
Gunnison Basin South	7,413	20	1,637	999	1,259	*3,896*	**3,896**	3,049	0	**3,049**	**14,378**
North Fork Valley	2,817	20	1,761	4,293	56	*6,111*	**6,111**	5,117	841	**5,958**	**14,906**
San Juans	2,516	22	3,137	1,076	652	*4,864*	**4,864**	348	0	**348**	**7,751**
Uncompahgre Plateau	5,192	34	8,766	7,886	218	*16,869*	**16,869**	19,025	0	**19,025**	**41,120**
Treatment Totals	**24,695**	**169**	**22,571**	**20,103**	**3,293**	***45,967***	**45,967**	**54,521**	**1,671**	**56,192**	**127,023**

Table 8. Alternative 3: Cover Type by PTA Treatment Category

Treatment Category	Cover Type	Total Acres	% of Parent Row
Commercial		**45,967**	**45%**
	Aspen	2,864	6%
	Aspen-Spruce Mix	18,008	39%
	Other*	1,005	2%
	Spruce	24,089	52%
Noncommercial**		**56,192**	**55%**
	Aspen	50,804	90%
	Aspen-Spruce Mix	5,388	10%
Grand Total PTA Acres		**102,159**	**100%**

**Other* cover types within the commercial Priority Treatment Areas would not be treated.

**In addition to the vegetation cover types targeted for noncommercial treatment listed here (aspen and aspen-spruce mix); other cover types in the noncommercial Priority Treatment Areas could be incidentally treated in order to facilitate implementation of prescribed burns in the targets. Approximately 4,750 acres of these "other" cover type acres are identified in detail and analyzed for treatment in the Fuels section, Chapter 3.

Access

In order to access proposed commercial treatments and remove forest products, Alternative 3 includes the following maximum roadwork. These represent maximum anticipated miles that may be constructed and maintained under this alternative, and are based on the maximum acreage analyzed for commercial treatment in Alternative 3. This roadwork would be conducted in accordance with the descriptions provided above (See *Activities Common to All Action Alternatives / Access).*

Table 9. Alternative 3 Maximum Road Treatments

	No Action	Alt 3
Road construction (miles)	0	80
Road reconstruction (miles)	0	336
*Existing system roads**	*0*	*248*
Existing non-system roads	*0*	*88*
Road decommissioning	0	168
Road maintenance (miles)*	0	497

**Assumed that 1/3 of system roads used for hauling would be reconstructed prior to use and the remaining 2/3 would simply be maintained.*

Summary of Alternatives

Table 10 provides a summary of the areas analyzed for both action alternatives and significant features of each alternative. The total area is represented in a variety of different subset breakouts.

Table 10. Summary of Alternatives.

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Action
Priority Treatment Areas (PTAs)			
Total PTA [1]	**0**	**190,014 acres**	**102,159 acres**
Commercial PTAs	0	112,768 acres (59% of total)	45,967 acres (45% of total)
Noncommercial PTAs	0	77,246 acres (41% of total)	56,192 acres (55% of total)
Priority Treatment Areas by species			
Commercial [2]			
Aspen	0	4,950 (4% of commercial PTAs)	2,864 (6% of commercial PTAs)
Spruce	0	68,121 (60% of commercial PTAs)	24,089 (52% of commercial PTAs)
Aspen-Spruce Mix	0	37,038 (33% of commercial PTAs)	18,008 (39% of commercial PTAs)
Other *(in mapped PTAs, but would not be treated)*		2,660 (2% of commercial PTAs)	1,005 (2% of commercial PTAs)
Noncommercial			
Aspen	0	69,114	50,804

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Action
		(89% of noncommercial PTAs)	(90% of noncommercial PTAs)
Aspen-Spruce Mix	0	8,132 (11% of noncommercial PTAs)	5,388 (10% of noncommercial PTAs)
Geographic limitations that resulted in the PTAs	N/A	Anywhere spruce, aspen, and spruce/aspen mix vegetation types occur on the GMUG outside of Colorado Roadless, Wilderness, and other special designations. These 718,000 acres then further refined via prioritization exercise, as detailed in Chapter 2 and Appendix F.	Spruce, aspen, and spruce/aspen mix treatments would occur under the same parameters as Alternative 2 except they would only occur within the Wildland Urban Interface areas as defined in this FEIS:1 mile buffer from communities, developed sites, and administrative facilities; and within ski area boundaries.
Treatments Types Available			
Public Safety Treatments (Y/N)			
Activities for Public Safety: Hazard trees – Dead/diseased spruce and aspen within 150 feet of communication sites; dispersed recreation sites; developed campgrounds and recreation sites; electrical power and above-ground telephone line corridors; and roads open to the public. Incidental species other than spruce and aspen may need to be removed, if pose same hazard. Buffer would increase to 300feet on uphill side of steep slopes. PTAs identified within WUI as defined in the FEIS	No	Yes	Yes
PTAs within WUI	0	102,159	102,159
Additional Hazard Tree Acres (outside PTAs)	0	17,388	24,695

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Action
Mechanical Treatments (Y/N)			
Mechanical Treatments: •Include contract commercial timber harvest (salvage), service contracts, stewardship contracts or agreements and to a lesser extent, Forest Service work crews or cooperators •Near communities and infrastructure, heavy fuels created by treatment would be masticated or piled and burned •Commercial mechanical treatments and non-commercial mechanical treatments involving large equipment on slopes < 40% •Non-commercial mechanical with chainsaws on slopes < or >40% •Cut and chunk, chipping, and hand-cut pile-burn in remote areas •Coppice cutting (in aspen)	No	Yes	Yes
Fire Treatments (Y/N)			
•Prescribed fire for aspen regeneration purposes •Disposal of activity fuels •Pile burning as needed to reduce slash.	No	Yes	Yes
Spruce Prescriptions Note: More detailed silvicultural prescriptions are in *Appendix A*.			
Activities in spruce	None	Recovery (salvage) prescription for >90% overstory mortality Stands with more live component treated for resiliency: - Resiliency prescription for stands with <40% overstory mortality - Recovery and resiliency prescription for >40% <90% overstory mortality	Same as Alt. 2.

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Action
Activities in aspen with spruce-fir understory		Mature aspen stand w/ < 50% SAD: Removal of live aspen to trigger sprouting (coppice). Young healthy aspen stands w/ < 50% SAD: selective removal of spruce-fir to set back successional process in the stand. Prescribed fire as needed to encourage aspen regeneration. Pile burn as needed to reduce fuel loading.	Same as Alt. 2.
Aspen Prescriptions Note: More detailed silvicultural prescriptions are in *Appendix A*.			
Activities in pure aspen	None	Coppice cutting and prescribed fire to promote regeneration in aspen with <50% overstory mortality, on opportunistic basis in aspen with >50% overstory mortality	Same as Alt. 2.
Activities in mixed conifer with aspen component[6]	None	Selective removal of spruce-fir and/or other conifer species to allow additional aspen. Broadcast burn in and around mixed stands with aspen to encourage aspen regeneration. Pile burn as needed to reduce fuel loading.	Same as Alt. 2.
Access			
Road reconstruction, (miles) *Includes both existing system and non-system roads*	0	538	336
Road construction (miles)	0	178	80
Decommissioned roads (miles)	0	*(360)*	*(168)*
Road maintenance (miles)	0	714	497

[1]Note that due to inaccuracies of vegetation type mapping, minor amounts of treatment could occur outside the actual GIS polygons used in analysis if the vegetation type, stand conditions and management area are such that treatment is warranted by the matrix. Acres rounded to nearest 1,000. Public safety areas, defined as road corridors and the wildland urban interface (WUI) are common to both action alternatives.

[2]As noted throughout this FEIS, commercial treatments would only occur on suitable timber lands as defined by the 1991 Forest Plan Amendment (USDA Forest Service, 1991, Appendix F).

AFFECTED ENVIRONMENT

GENERAL DESCRIPTION

The Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG) are located in west-central Colorado (Figure 2), and comprise about 3.1 million acres within those three proclaimed national forests. The three national forests are administered as one unit, with the Forest Supervisor's office in Delta, Colorado.

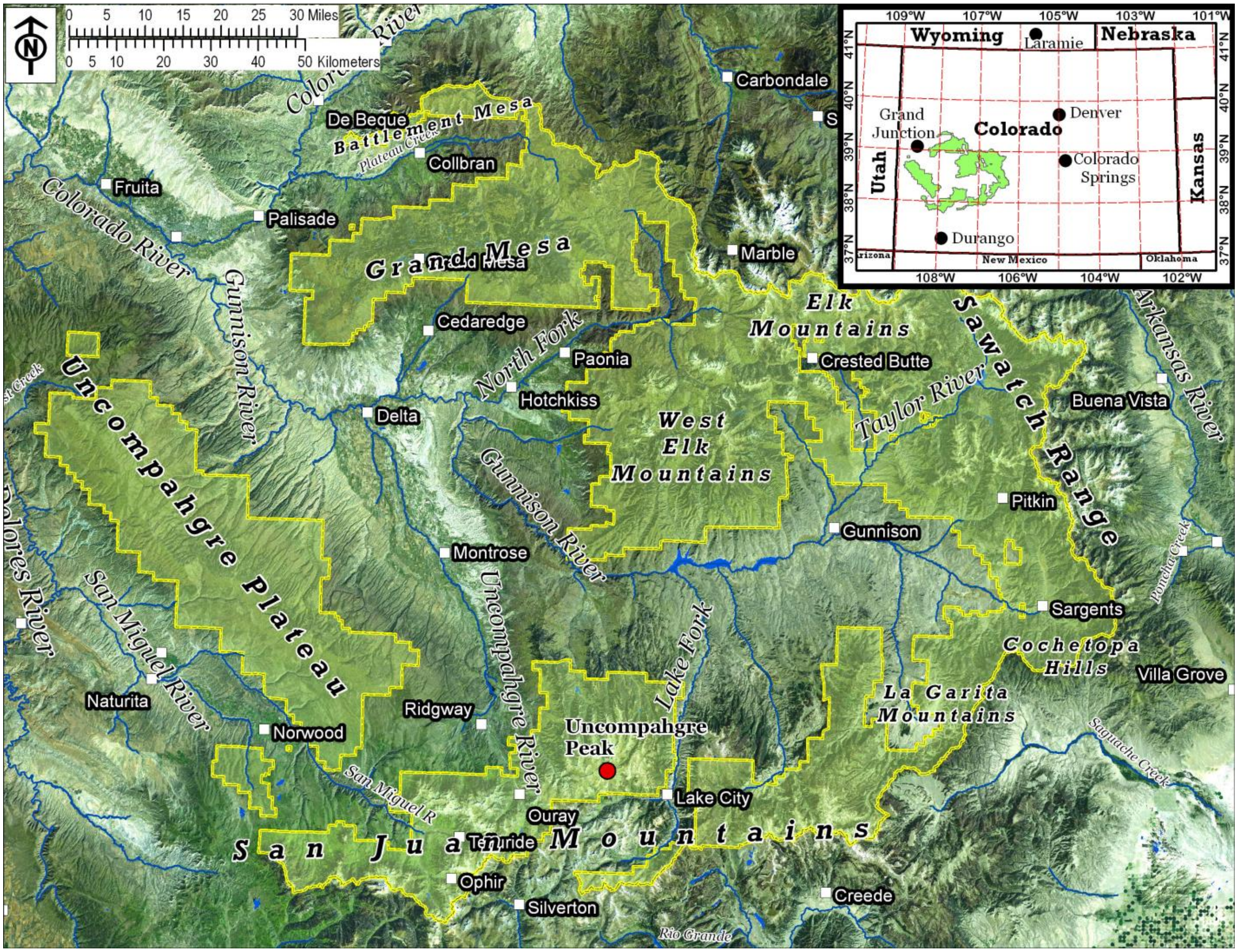

Figure 2. The Grand Mesa, Uncompahgre, and Gunnison National Forests.

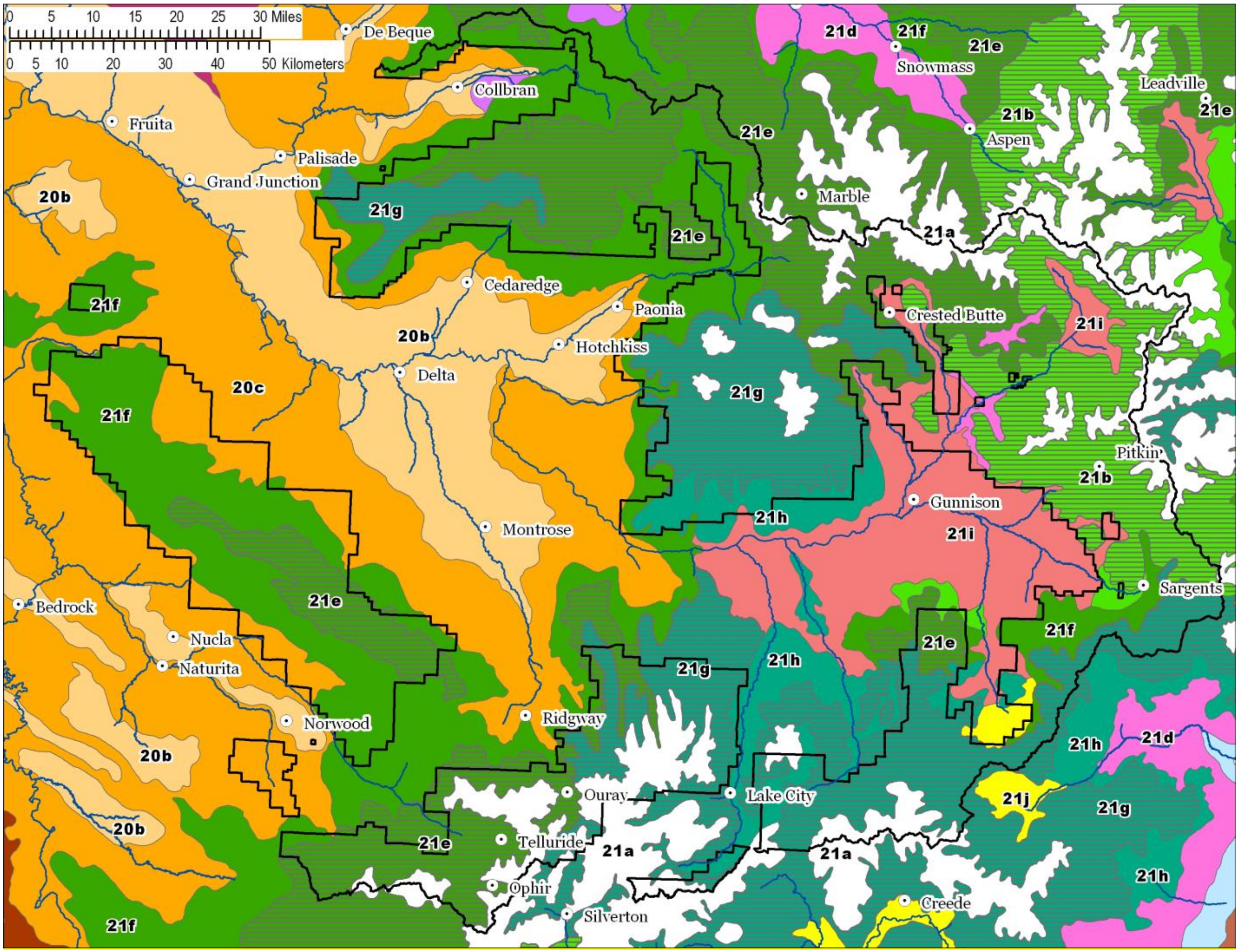

Figure 3. Ecoregions of the Grand Mesa, Uncompahgre, and Gunnison National Forests (Chapman and others 2006).

Ecoregions of the Grand Mesa, Uncompahgre, and Gunnison National Forests are shown in Figure 3, legend in Figure 4. The Uncompahgre and Gunnison River valleys below Montrose are in Ecoregion 20b, Shale and Sedimentary Basins; the upper Gunnison Basin is a large example of 21i, Sagebrush Parks. Subalpine forests dominate the Grand Mesa, Sawatch Area, and the West Elk Mountains; the Alpine Zone, above timberline, is prominent in the Eastern and Middle San Juans and the Elk Mountains.

The ecoregions shown in Figure 3 were developed in 2006 by a cooperating group of agencies, including USDA Forest Service and Natural Resources Conservation Service, Colorado Division of Wildlife and Department of Public Health, Bureau of Land Management, U. S. Geological Survey, and the Environmental Protection Agency (Chapman and others 2006).

Figure 4. Legend for Figure 3.

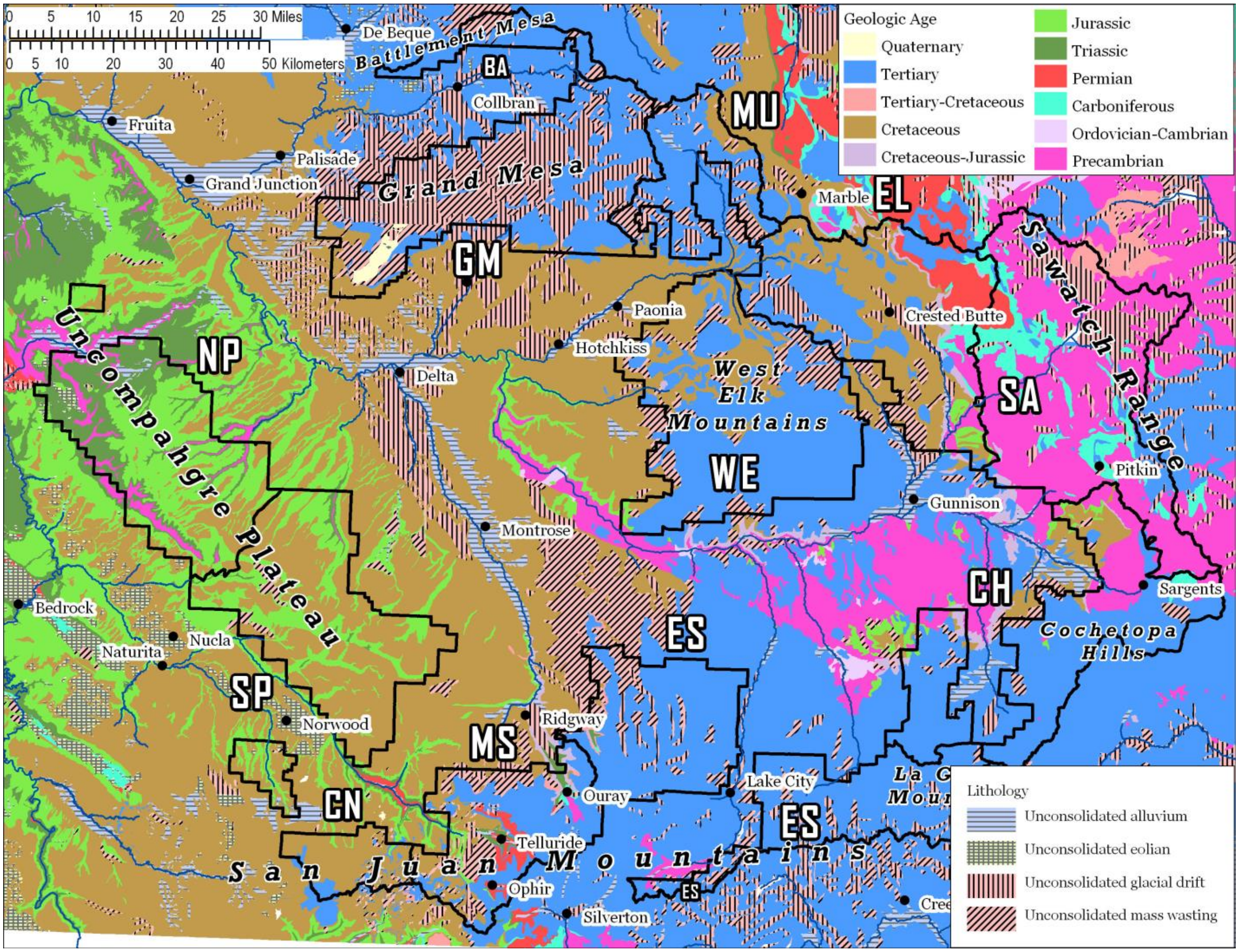

Figure 5. Surficial geology of the Grand Mesa, Uncompahgre, and Gunnison National Forests (Day and others 1999). Two-letter landscape area codes are explained in Table 11.

The Grand Mesa, Uncompahgre, and Gunnison National Forests have considerable geologic diversity (Figure 3-6). Bedrock types include Precambrian metamorphic, igneous and metavolcanic rocks; Mississippian, Devonian, Ordovician and Cambrian carbonates (limestones), Jurassic and Cretaceous-aged sedimentary rocks; Eocene-aged sedimentary rocks; volcanic lava flows, ash flow deposits and intrusive rocks of Miocene and Oligocene ages, along with recent unconsolidated deposits as a result of glaciation (glacial drift), alluvial activity, and mass wasting events (for example, landslides).

Most of the Grand Mesa, West Elk, and Eastern San Juan areas are Tertiary volcanics and flows; a lot of the surface of the Grand Mesa was later changed by glaciation and mass-wasting (shading in Figure 3-6). The Muddy and Battlement Mesa areas are mostly comprised of Tertiary sedimentary rocks. The Sawatch area is largely Precambrian, with some glaciation evident in the northeastern portion. The Middle San Juans, Elk Mountains, and Cochetopa Hills are mixed.

The Southern Plateau and Cones areas are dominated by Cretaceous sedimentary rocks; the Northern Plateau area has more Jurassic and Triassic rocks.

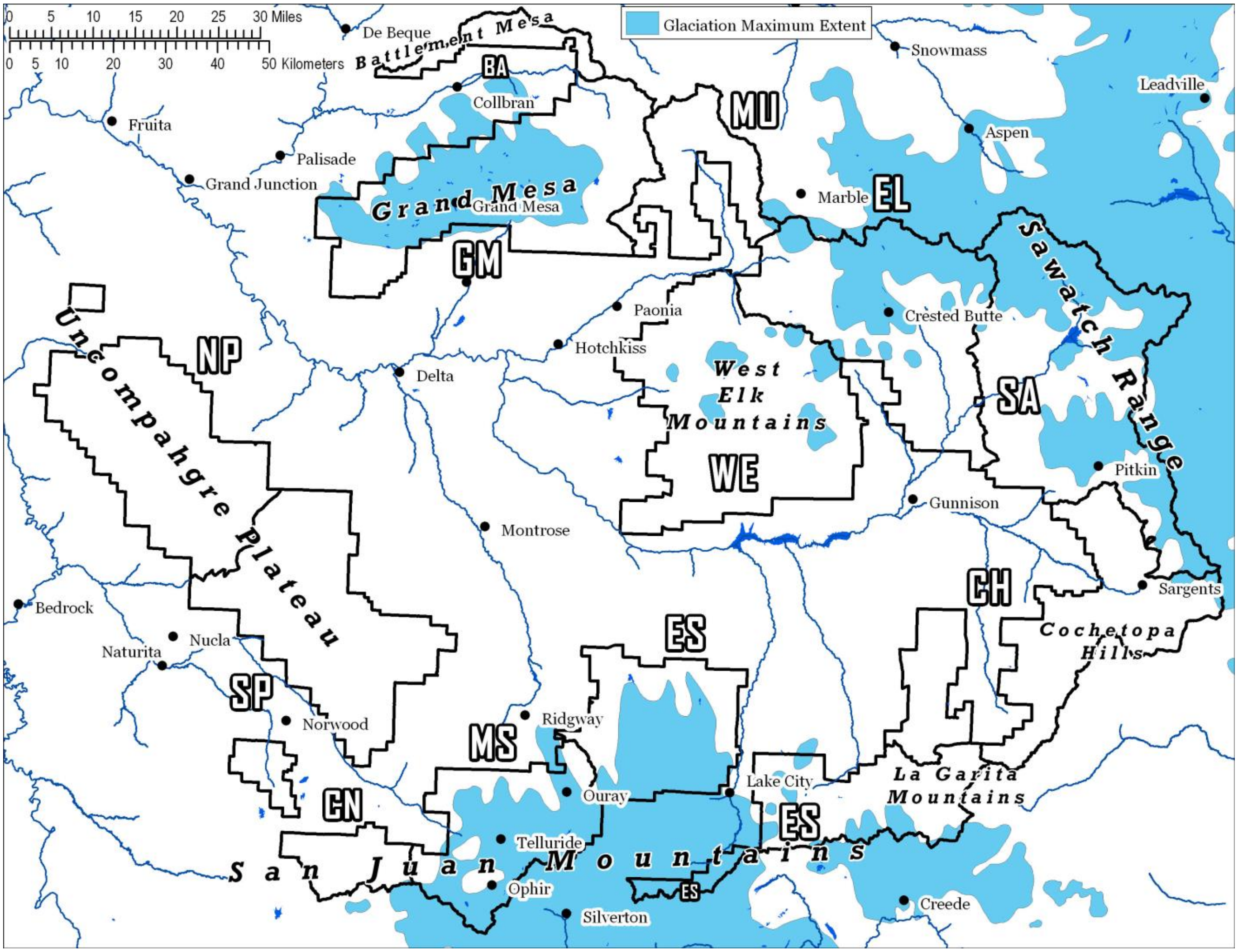

Figure 6. Landscapes that have been glaciated on the GMUG (Matthews and others 2003). Two-letter landscape area codes are explained in Table 11.

Glaciers have covered much of the top of the Grand Mesa and the higher-elevation portions of the Sawatch Range, Middle San Juans, and Eastern San Juans areas, and the eastern part of the Elk Mountains (Figure 6). The West Elk Mountains and La Garita Mountains had smaller, patchier glaciers. Glaciation has been absent in the Northern Plateau, Southern Plateau, Muddy, Battlement Mesa, and Cochetopa Hills areas.

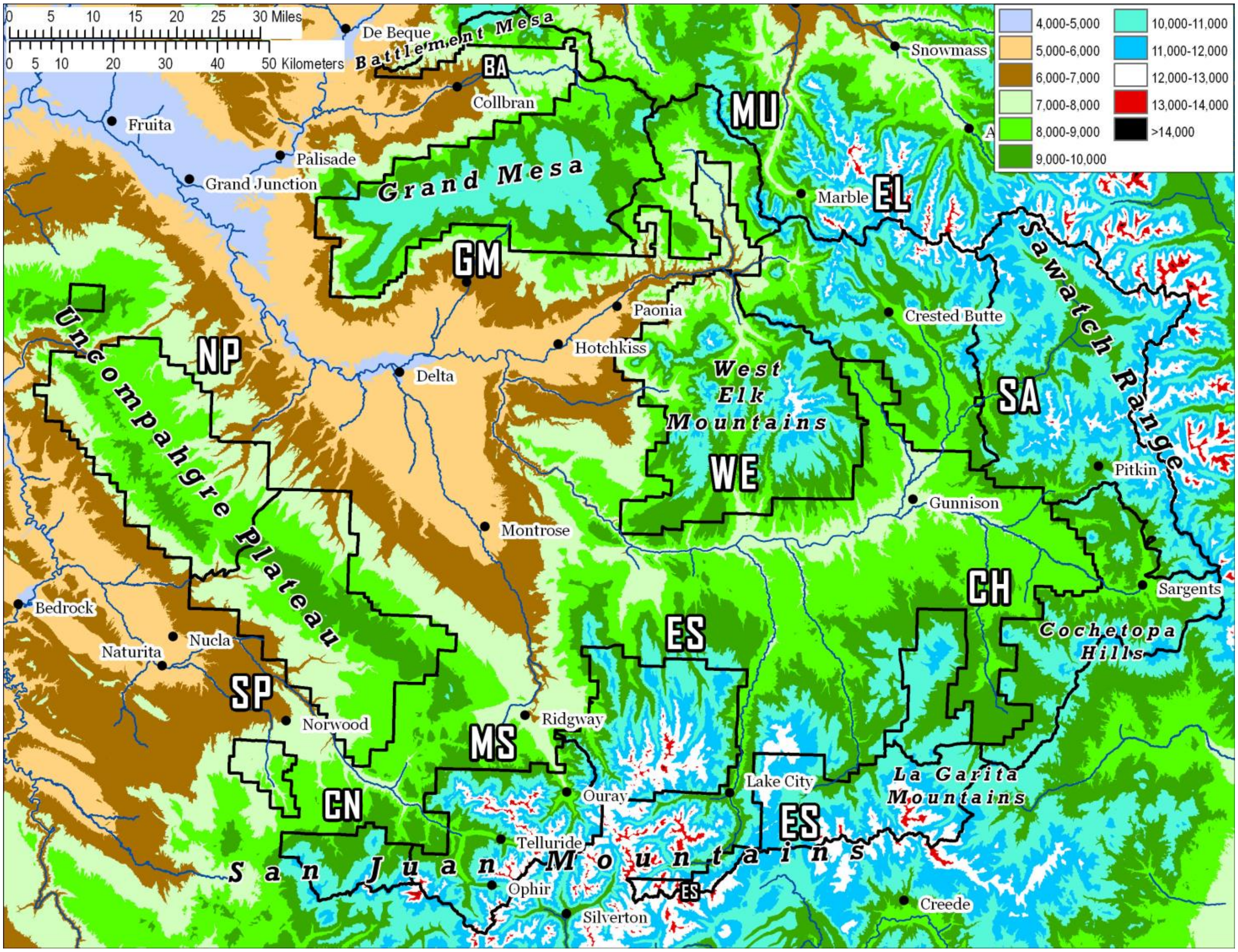

Figure 7. Elevations of the Grand Mesa, Uncompahgre, and Gunnison National Forests. Landscape areas are shown by black lines; abbreviations for them are shown in Table 1.

Elevations of the Grand Mesa, Uncompahgre, and Gunnison National Forests range from about 5,800 ft (1,770 m) on the west foothills of Battlement Mesa and the south end of the Uncompahgre Plateau, to over 14,200 ft (4,330 m) on the high peaks of the San Juan and Sawatch Mountains (Figure 7, Table 11). The Battlement Mesa, Southern Plateau, and Muddy areas are lower in average elevation, while the Sawatch Mountains and San Juan Mountains are higher. All of the Grand Mesa, Uncompahgre, and Gunnison National Forests are on the western slope, as the Continental Divide forms the eastern and southeastern boundaries of the National Forests.

Table 11. Elevations of areas shown in Figure 7.

Code	Landscape Area Name	Elevation, feet Minimum	Mean	Maximum
BA	Battlement Mesa	5,840	8,551	11,053
CH	Cochetopa	8,222	9,922	12,670
CN	Cones	8,363	10,108	13,464
ES	Eastern San Juans	7,657	11,031	14,350
EL	Elk Mountains	7,029	9,924	14,219
GM	Grand Mesa	6,001	9,519	11,322
MS	Middle San Juans	7,313	10,741	14,117
MU	Muddy	6,355	8,769	12,733
NP	Northern Plateau	6,227	8,270	9,875
SA	Sawatch Mountains	8,320	10,658	13,822
SP	Southern Plateau	5,830	8,218	10,010
WE	West Elks	6,263	9,489	13,031

THREATENED, ENDANGERED, AND PROPOSED PLANT SPECIES

There are two Threatened plant species on or near the Grand Mesa, Uncompahgre, and Gunnison National Forests: De Beque phacelia (*Phacelia submutica*)[2] and Colorado hookless cactus (*Sclerocactus glaucus*). There are no Endangered plant species on or near the GMUG, nor are there any plant species here proposed for listing as Threatened or Endangered.

Phacelia submutica J. T. Howell (PHSU6). De Beque phacelia

This species is sometimes known as *Phacelia scopulina* (A. Nelson) J. T. Howell var. *submutica* (J. T. Howell) Halse, but the taxonomy was solidified (for Endangered Species Act purposes) to *Phacelia submutica* when the species was listed. Listing as a Threatened species proposed on June 23, 2010 (U. S. Fish and Wildlife Service 2010a), finalized on July 27, 2011 (U. S. Fish and Wildlife Service 2011). *Phacelia submutica* was first described by J. T. Howell in 1944 (Howell 1944), based on specimens from near De Beque, Colorado collected by George Osterhout in 1911.

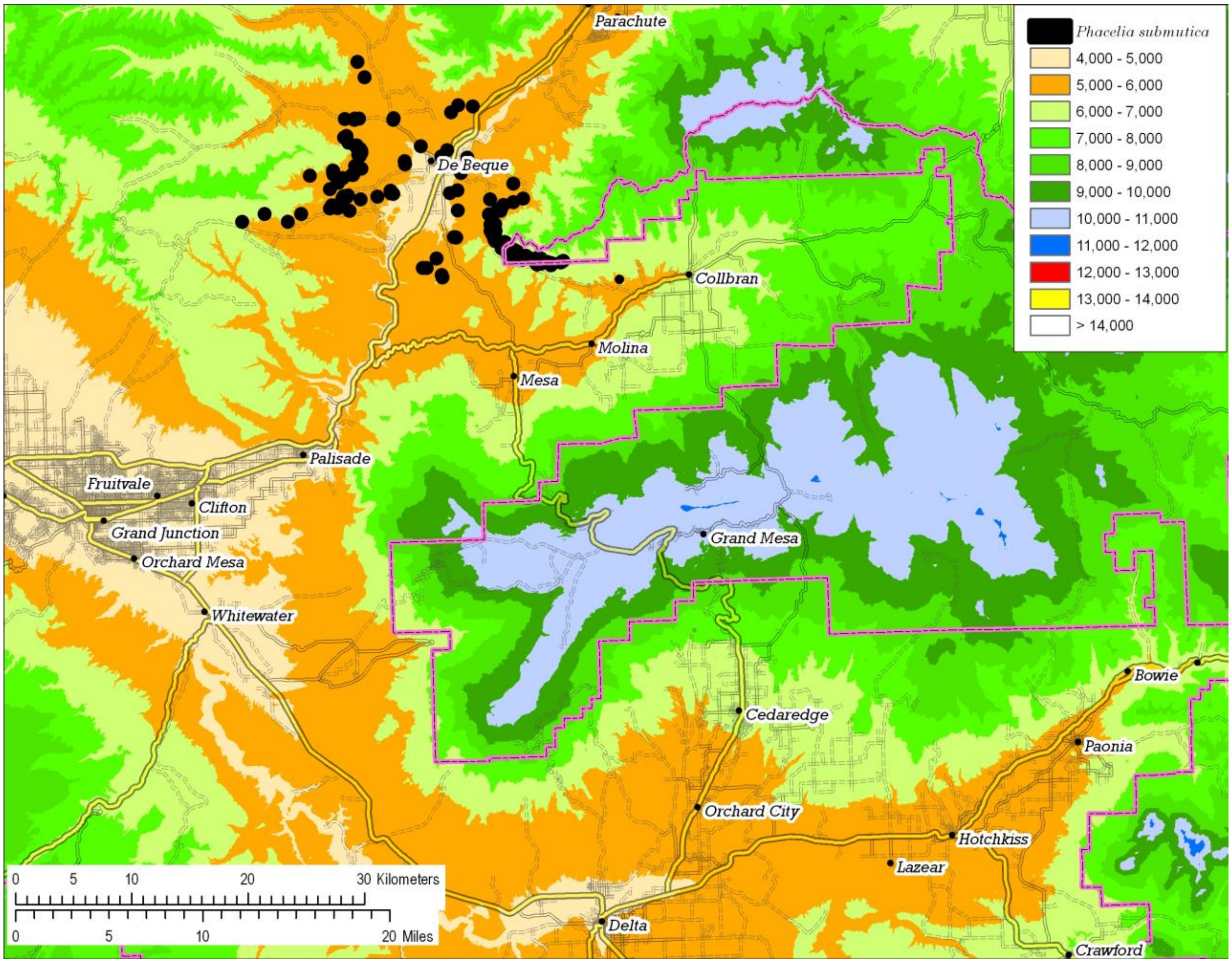

Figure 8. Distribution of *Phacelia submutica* with relation to the Grand Mesa, Uncompahgre, and Gunnison National Forests.

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[2] Species names follow Weber and Wittmann 2012.

Phacelia submutica is known from over 130 locations, all within about 17 Km (10.6 mi) from the town of De Beque, Colorado, mostly within 14 Km (9 mi) of De Beque (Figure 7, Colorado Natural Heritage Program 2013c). It is a spring annual plant that usually occurs on nearly barren heavy-clay soils, derived from the Atwell and Shire Members of the Wasatch Formation (Donnell and others 1992, Ladyman 2003).

There are about fifty small sites for *Phacelia submutica* on the Grand Mesa National Forest, ranging in size from less than 0.1 acre to 3.4 acres, averaging 0.35 acres (figure 7). The number of plants at each site ranges from 3 to approximately 5,000, averaging about 325. Most of these sites are steep and inaccessible to motor vehicles. The species is annual, emerging (in favorable-moisture years) in March, blooming later March to late April. To date, no populations have been found higher than 5,600 feet elevation.

The sites for *Phacelia submutica* on the Grand Mesa National Forest are surrounded by semi-desert saltbush, piñon-juniper, and at higher elevations Wyoming big sagebrush. These sites are several thousand feet below any spruce-fir stands, and the roads leading to

Phacelia submutica sites would be inappropriate for timber haul roads, as they are generally not graveled and closed or inaccessible during muddy seasons. Also, these sites are in watersheds that have no spruce-fir in them, that would not be considered for this project. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Phacelia submutica* is approximately 11.5, 11.3 and 12 miles respectively for both Alternative 2 and 3 from any Grand Mesa geographic treatment area. The other Geographic Areas treatment locations are >27 miles from any known *Phacelia submutica*.locations.

Sclerocactus glaucus (K. Schumann) L. Benson (SCGL). Colorado hookless cactus

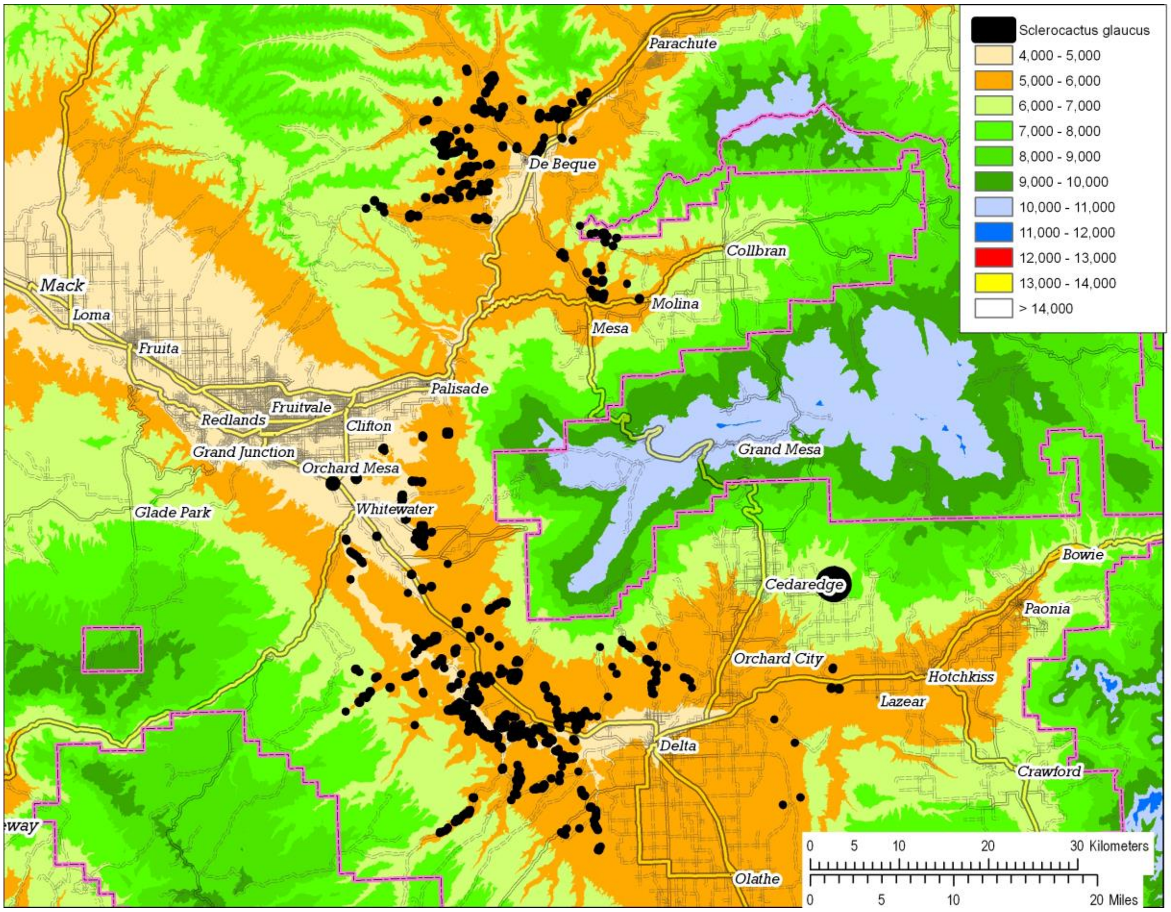


Figure 9. *Sclerocactus glaucus* and the GMUG National Forest.

Until the 21st century, *Sclerocactus glaucus* was considered to occur in west-central Colorado and north-central Utah. It was listed as a Threatened species on October 11, 1979 (Carey 1979). In 2009, the Utah populations were accepted (for Endangered Species Act purposes) as two separate species, so what had been formerly known as *Sclerocactus glaucus* was split into three (U. S. Fish and Wildlife Service 2009). The "common" name of the west-central Colorado populations was changed to "Colorado hookless cactus."

Sclerocactus glaucus occurs in three distinct distribution patterns: 1) Lower Gunnison valley between Delta and Grand Junction; 2) Middle Grand Valley within about 20 Km (12½ mi) of De Beque; and 3) Lower North Fork Valley above Delta (Figure 9). This species is only known from Colorado.

There are about ten known sites for *Sclerocactus glaucus* on the Grand Mesa National Forest, although several more may be discovered in the future. Within the known sites, plants of *Sclerocactus glaucus* are usually widely dispersed, often protected by sagebrush, saltbush, or greasewood shrubs. Sites range from less than 0.1 acre to 2.2 acres in size, averaging 1.0 acre. Number of plants at each site ranges from 1 to 22 as counted, and from 5 to 50 as estimated; averaging 5 as counted and 16 as estimated.

The sites for *Sclerocactus glaucus* on the Grand Mesa National Forest are surrounded by semi-desert saltbush, piñon-juniper, and at higher elevations Wyoming big sagebrush. These sites are several thousand feet below any spruce-fir stands, and the roads leading to these sites would be inappropriate for timber haul roads, as they are generally not graveled and closed or inaccessible during muddy seasons. Also, these sites are in watersheds that have no spruce-fir in them, that would not be considered for this project. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Sclerocactus glaucus* is approximately 5.2, 2.0 and 7.5 miles respectively for both Alternative 2 and 3 from any Grand Mesa geographic treatment area. Other known Sclerocactus glaucus locations have a greater distance from other geographic area treatment locations (North Fork Valley >15, Uncompahgre Plateau >15, Gunnison Basin North >25, Gunnison Basin South 38.0, and >45 miles from San Juan)

Determinations. Because both *Phacelia submutica* and *Sclerocactus glaucus* are not known from areas that would be affected by treatments or activities associated with any of the alternatives for the SBEADMR project, it is our determination that there will be **"no effect"** to either species.

SENSITIVE SPECIES

Forest Service Sensitive plant species are those plants identified by the Regional Forester (USDA Forest Service 2005-2015) for which population viability is a concern. Forest Service Sensitive species are managed so that Forest Service actions ensure that these species do not become threatened or endangered (Forest Service Manual 2670.22). This section will describe those sensitive species with the potential to occur, their range and distribution, habitat, management concerns, and the potential for those species to potentially be affected by activities associated with this project. This information is summarized in Table 13 below.

Two Federally Threatened and twenty-two Region 2 sensitive species occur on the GMUG or have the potential to occur on the GMUG (Table 12).

Table 12. Plant species that occur on the GMUG or with the potential to occur on the GMUG. All non-Threatened species are designated Sensitive in the Rocky Mountain Region (Region 2).

Name[a]	Code[b]	Common Names(s)	Status[c]	GMUG?	Grand Valley District	Paonia District	Ouray District	Norwood District	Gunnison District	Colorado Natural Heritage Program Rating, Sept. 2013[d]
Aliciella sedifolia	ALSE11	stonecrop gilia, stonecrop gily-flower	S	Yes			Y		Y	G1 / S1
Astragalus iodopetalus	ASIO2	violet milkvetch, purple milkvetch	S	Maybe		M		M	M	G2 / S1
Astragalus leptaleus	ASLE9	park milkvetch	S	Maybe					M	G4 / S2
Astragalus microcymbus	ASMI3	skiff milkvetch	S	Maybe					M	G1 / S1
Botrychium paradoxum	BOPA9	peculiar moonwort	S	Yes					Y	NR
Braya glabella	BRGL	smooth northern-rockcress, smooth rockcress, arctic braya	S	Yes					Y	G5TNR / S1
Calochortus flexuosus	CAFL	winding mariposa lily	S	Maybe				M		G4 / S2
Carex diandra	CADI4	lesser panicled sedge	S	Yes						G5 / S1
Drosera rotundifolia	DRRO	roundleaf sundew	S	Yes					Y	G5 / S2
Epipactis gigantean	EPGI	stream orchid	S	Maybe	M					G4 / S2S3
Eriophorum chamissonis	ERCH7	Chamisso's cottongrass	S	Yes	M		M	M	Y	G5 / S1
Eriophorum gracile	ERGR8	slender cotton-grass	S	Yes	M	Y		Y	Y	G5 / S2
Kobresia simpliciuscula	KOSI2	simple bog sedge	S	Yes					Y	G5 / S2
Machaeranthera coloradoensis	MACO13	Colorado tansy-aster	S	Yes			M	M	Y	G3 / S3
Neoparrya lithophila	NELI2	Bill's neoparrya	S	Maybe					M	G3 / S3
Phacelia submutica	PHSU6	De Beque phacelia	T	Yes	Y					G2 / S2
Physaria pulvinata	*	cushion bladderpod	S	Maybe						G1 / S1
Physaria scrotiformis	*	west silver bladderpod	S	Maybe			M		M	G1 / S1
Ranunculus gelidus	RAGE	ice cold buttercup, arctic buttercup, tundra buttercup	S	Yes			Y		Y	G4G5 / S2
Salix candida	SACA4	sageleaf willow	S	Yes					Y	G5 / S2
Sclerocactus glaucus	SCGL	Colorado hookless cactus	T	Yes	Y					G2G3 / S2S3
Sphagnum angustifolium	SPAN11	sphagnum, narrowleaf peat moss	S	Yes			M	M	Y	G5 / S2
Thalictrum heliophilum	THHE2	Cathedral Bluff meadow-rue, sun-loving meadow-rue	S	Yes	Y					G2 / S2
Utricularia minor	UTMI	lesser bladderwort	S	Yes	Y				M	G5 / S2

*. Code not yet established. a. Names follow Weber and Wittmann 2012. b. Codes follow USDA Natural Resources Conservation Service 2014. c. S = Sensitive, T = Threatened. d. Last available ranking; see http://explorer.natureserve.org/ranking.htm.

SPECIES DESCRIPTIONS

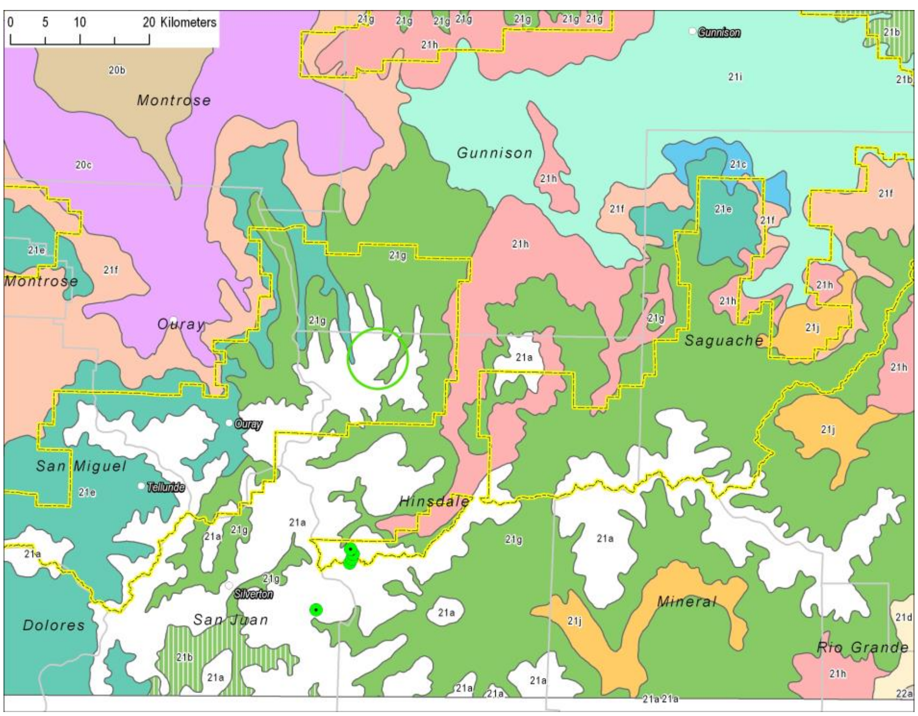
Aliciella sedifolia (Brandegee) J. M. Porter (stonecrop gilia). *Aliciella sedifolia* is tracked by Colorado Natural Heritage Program and is globally critically imperiled (G1) and critically imperiled (S2) in the state of Colorado. *Aliciella sedifolia* is also known as *Gilia sedifolia* Brandegee.

Habitat and Natural History: Stonecrop gilia occurs in the middle to upper alpine zone, on barren small-rock screes derived from light-colored tuffs. Stonecrop gilia is an unusual biennial, or possibly a short-lived perennial with succulent leaves. It is known from elevations of 11,800 to 13,400 feet.

Range/Distribution: This species is known from only four populations; the type locality ("Sheep Mountain, Uncompahgre Range") has still not been definitely located. The four populations are in the San Juan Mountains, on the Gunnison District of the GMUG and Rio Grande NF (Figure 10). Much potential habitat has yet to be searched for this species.

Management and conservation issues: This species appears to be very rare after survey efforts of perhaps a quarter of its potential habitat. Threats to species include human trailing and other recreation, sheep grazing and its secondary impacts, mining, effects of small population sizes, global climate change, and pollution.

Potential to occur in project area: This species is only known to occur in the middle to upper alpine zones, well above the elevations where the SBEADMR project will occur. *Aliciella sedifolia* does not have the potential to occur in the project area or to be impacted by associated activities. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Aliciella sedifolia* is approximately 14, 5.6 and >14 miles respectively for Alternative 2 and 20, 5.6, and >20 miles for Alternative 3 from any Gunnison Basin South geographic treatment area. Other known *Aliciella sedifolia* locations have a greater distance from other treatment locations within Gunnison Basin South and is >19 miles from any proposed activity in the San Juan geographic area.



References: Warren 2003; Anderson 2004b; Porter 1998; Colorado Natural Heritage Program 2013b

Figure 10. The total world distribution of *Aliciella sedifolia*. All populations are in the Alpine zone; the green circle shows an area needing more detailed ground searches

Astragalus iodopetalus **(**Rydberg) Barneby. (violet milkvetch) *Astragalus iodopetalus* is tracked by Colorado Natural Heritage Program and is ranked globally imperiled (G2) and critically imperiled in the state of Colorado.

Habitat and Natural History: *Astragalus iodopetalus* occurs on dry stony hillsides and benches near oak in piñon-juniper, ponderosa pine, oak –piñon or sagebrush. *Astragalus iodopetalus* is known from elevation of 6,512-7,264 feet.

Range/Distribution: *Astragalus iodopetalus* occurs in New Mexico and Colorado. In Colorado it is known from Archuleta, Gunnison, La Plata, Montrose, Montezuma, and Hinsdale counties. Populations are known from private, tribal, Forest Service (one population on San Juan NF) and National Park Service lands. *Astragalus iodopetalus* is only known from near the GMUG in the Gunnison Basin (Figure 11).

Management and conservation issues: It appears that the plants are palatable to deer and in Colorado *Astragalus iodopetalus* may be threatened by domestic sheep grazing and mule deer grazing. Additionally, several historic records are now under Blue Mesa Reservoir.

Potential to occur in Priority Treatment Area: *Astragalus iodopetalus* occurs in sagebrush and oak, below the lower treeline. None of the sites are forested; all are well below any spruce-fir or aspen stands. None are close to haul roads that might be used by SBPEADMR project implementation. *Astragalus iodopetalus* does not have the potential to occur in the project area or to be impacted by associated activities. Although the species is only one mile from a non-commercial treatment in the Gunnison Basin South geographic area, habitat is not present where project activities will occur. The closest Priority Treatment Area, hazard tree treatment, or new roads outside the PTA's is approximately 1.0, 3.0 and 2.6 respectively for both alternatives. Other known *Astragalus iodopetalus* locations have a greater distance from other treatment locations within Gunnison Basin South and is >8 miles from any proposed activity in the Gunnison Basin North and North Fork Valley, >7.5 in San Juan, and >13 miles from any activity within the Uncompahgre Plateau geographic area.

References: Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b; Barneby 1947; Barneby 1964.

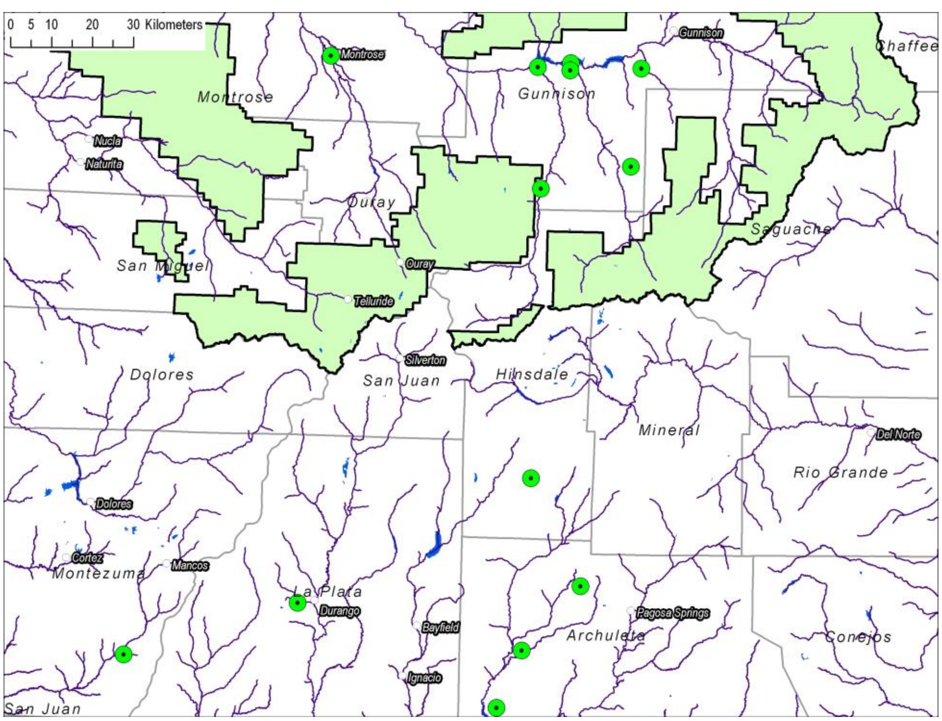


Figure 11. The Colorado distribution of *Astragalus iodopetalus*; it also occurs in northern and north-central New Mexico. So far, no populations on the GMUG National Forest.

Astragalus leptaleus A. Gray. (park milkvetch) *Astragalus leptaleus* is tracked by the Colorado Natural Heritage Program and is ranked apparently secure globally (G4) and imperiled (S2) in the state of Colorado.

Habitat: *Astragalus leptaleus* grows in lower elevation riparian areas and sub-riparian swales, typically sedge-grass dominated meadows, swales and hummocks, and streamsides. It is known from elevations of 2,900 to 9,500 ft. but is thought to occur primarily in the montane zone in Colorado at elevations from 6,000 to 9,500 feet. *Astragalus leptaleus* is a rhizomatous perennial with a taproot and branching subterranean caudices of the pea family (Fabaceae).

Range/Distribution: *Astragalus leptaleus* is considered a regional endemic that is known from Colorado, Idaho, Montana and Wyoming. In Colorado it is known from Jackson, Larimer, Summit, Park and Gunnison Counties. Ownership includes private, BLM, and Forest Service lands. On the GMUG, *Astragalus leptaleus* is known to occur in the Gunnison Basin (Figure 12), and has the potential to occur in FS lands on the Gunnison District[3].

Management and conservation issues: *Astragalus leptaleus* is thought to be vulnerable primarily due to loss, degradation and/or fragmentation of habitat. As *Astragalus leptaleus* is known from lower elevation riparian areas and hay meadows, it is thought to have vulnerability to invasive species, activities that dry habitat out like hay farming, and livestock grazing. Other potential threats include ORV, camping road development, drought, and potentially closing of the forest canopy due to fire suppression.

Potential to occur in project area: There is the potential for *Astragalus leptaleus* to occur in the SBEADMR Priority Treatment Areas, especially on the Gunnison District in areas where suitable habitat exists. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Astragalus leptaleus* is approximately 4.5, 3.3 and >15 miles respectively for both Alternative 2 and 3 from any Gunnison Basin North geographic treatment area. Other known *Astragalus leptaleus* locations are greater in distance from other treatment locations within Gunnison Basin North and >10 miles from any proposed activity in the Gunnison Basin South, >20 miles from San Juan, and >23 miles from North Fork Valley.

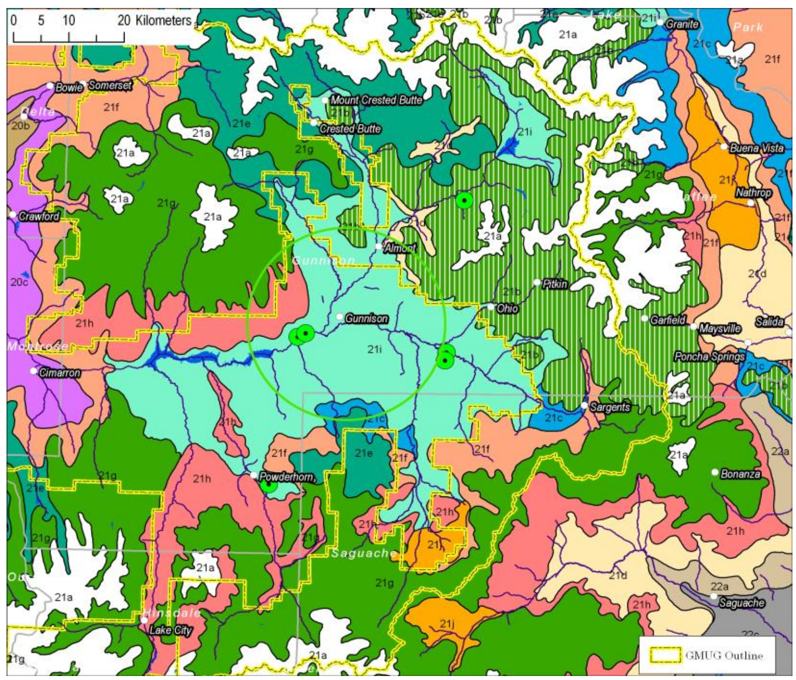


Figure 12. The populations of *Astragalus leptaleus* in or near the GMUG

References: Ladyman 2006; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b; Barneby 1964.

[3] There is one recorded site on the Gunnison National Forest, in the Fossil Ridge wilderness, a recent herbarium specimen that has not yet been confirmed.

Astragalus microcymbus Barneby. (skiff milkvetch). Federal Candidate species. *Astragalus microcymbus* has a global rank of G1 indicating the species is critically imperiled across its range, and a State rank of S1 (Colorado Natural Heritage Program 2014) indicating the species is critically imperiled within the State of Colorado.

Habitat and Natural History: *Astragalus microcymbus* is a perennial forb in the pea family (Fabaceae). It is found in open, park-like landscapes in sagebrush-steppe ecosystems on rocky or cobbly, moderate to steep slopes of hills and draws. The areas where *Astragalus microcymbus* are found are generally distinct from surrounding habitat as in being more sparsely vegetated and apparently drier.

Range/Distribution: *Astragalus microcymbus* has limited range and distribution in Gunnison and Saguache Counties in Colorado. It is known from about 25 populations (grouped into three “populations”) in two general geographic locations (Figure 13). The populations are known from BLM public lands and private lands, and it has never been observed to occur on the National Forest.

Management and conservation issues: FWS has described threats to *Astragalus microcymbus* as including recreation, roads, trails, habitat fragmentation, and degradation. It is thought that the threats to this species, though moderately impactful individually, may be serious cumulatively, and *Astragalus microcymbus* is facing them through much of its range.

Potential to occur in project area: *Astragalus microcymbus* is known from the Gunnison Basin, but does not occur along roads that could be used for SBEADMR Priority Treatment Areas. *Astragalus microcymbus* does not have the potential to occur in the project area or to be impacted by associated activities. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA’s from any known location of *Astragalus microcymbus* is approximately 10.0, 8.0 and 10.0 (24 miles for alternative 3) miles respectively for both Alternative 2 and 3 from any Gunnison Basin North geographic treatment area. There are other known *Astragalus microcymbus* locations which have a greater distance to other treatment locations within Gunnison Basin North. *Astragalus microcymbus* is >17 miles from any proposed activity in the Gunnison Basin South geographic area, >23 miles from the North Fork Valley, and >25 miles from activity in the San Juan activity area.

References: U.S. Fish and Wildlife Service 2010b; U.S. Fish and Wildlife Service 2013; Colorado Natural Heritage Program 2013b; Barneby 1964.

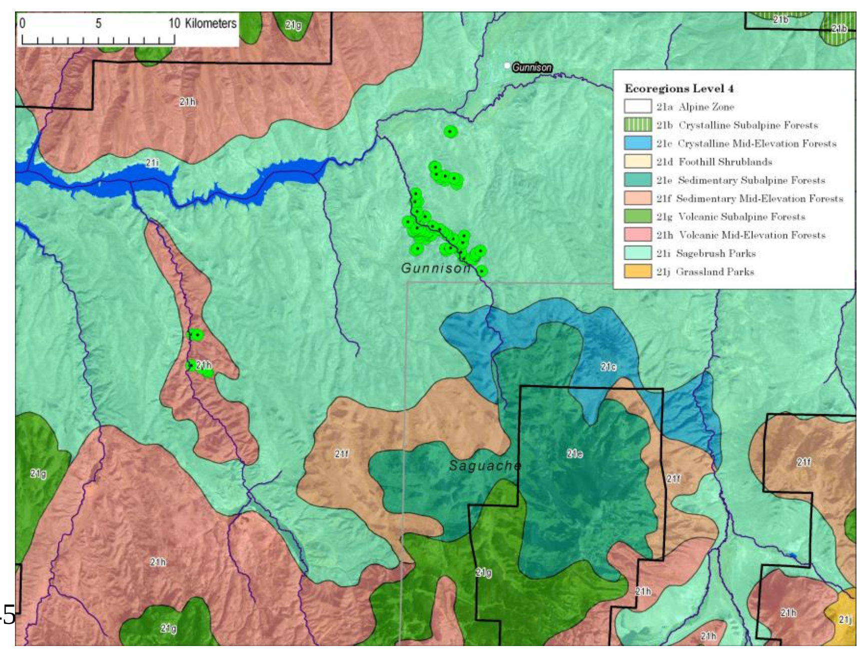


Figure 13. The total world distribution of *Astragalus microcymbus*. No populations on the Forest

Botrychium paradoxum W. H. Wagner. (peculiar moonwort) *Botrychium paradoxum* is not yet ranked or tracked by Colorado Natural Heritage Program. Globally it is ranked as vulnerable, G3/G4.

Habitat and Natural History: *Botrychium paradoxum* is a small perennial herb in the adder's-tongue fern family (Ophioglossaceae) that produces spores in late summer. *Botrychium paradoxum* is a plant of mesic subalpine mountain meadows dominated by grasses, sedges and in some cases, dense herbaceous and shrubby cover (Farrar 2011). In Colorado, suitable habitat has not been clearly determined, but peculiar moonwort has been found in open rocky alpine or subalpine areas at elevations above approximately 10,500 feet.

Range/Distribution: *Botrychium paradoxum* occurs from south central Utah and Colorado northward to Montana and Washington and into southern British Columbia, Alberta and Saskatchewan, and is disjunct in the Sierra Mountains of east-central California. The Colorado distribution is limited to one location on the Grand Mesa, Uncompahgre and Gunnison National Forest in Crested Butte (Figure 14).

Management and conservation issues: There is little information about impacts to *Botrychium paradoxum* in Colorado, but as it is known from a single population at this time, and is sensitive to extirpation through this part of its range.

Potential to occur in project area: There is the potential for *Botrychium paradoxum* to occur throughout the SBEADMR Priority Treatment Areas where suitable habitat exists. *Botrychium paradoxum* has been observed approximately 45 ft. from edge of the Gunnison Basin North geographic area for alternative 2 and 3. It is located in the Crested Butte commercial treatment area. *Botrychium paradoxum* known location is not near any other geographic areas.

References: Farrar 2011, Colorado Natural Heritage Program 2014, Farrar and Popovich 2012.

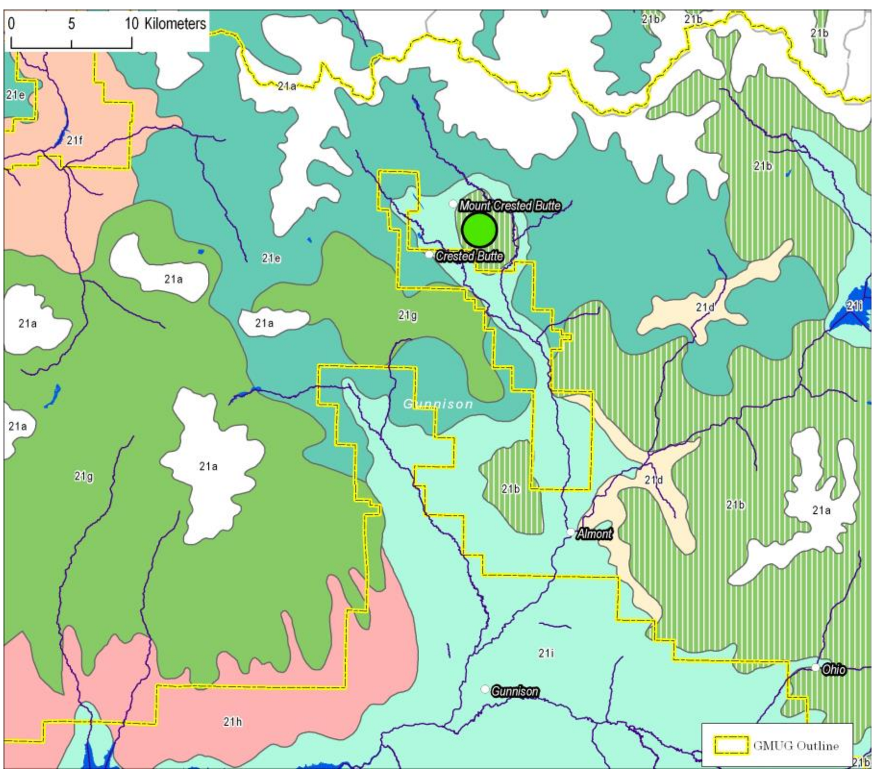


Figure 14. The only known population of *Botrychium paradoxum* in Colorado, and it was seen in this location only once. Not rated by Colorado Natural Heritage Program.

Braya glabella . Richardson. (smooth northern-rockcress). *Braya glabella* is globally it is a ranked as secure (G5T5?), but is ranked critically imperiled by the state (S1) and is tracked by Colorado Natural Heritage Program. Recent taxonomic studies assign no subspecies to *B. glabella*.

Habitat and Natural History: *Braya glabella* is a perennial herb in the mustard family (Brassicaceae). In Colorado, it is known to occur on calcareous substrates, especially Leadville Limestone; sparsely vegetated slopes above timberline with fine gravels or on disturbed sites associated with long-inactive mines. Elev. 12,000-13,000 ft.

Range/Distribution: *Braya glabella* is a circumboreal species known from subarctic mountains and in the northern Rockies in Canada. Disjunct populations are known in the Rocky Mountain alpine zone of Colorado and Wyoming. Known populations in Region 2 are small and isolated, and on the GMUG primarily occur in the Sawatch Mountains (Figure 15).

Management and conservation issues: In Colorado, most known populations of *Braya glabella* are on National Forest System lands. Recreation and mining are thought to be the most likely to affect this taxon, along with invasive plants, herbivory, global warming and air pollution. Johnston (2008?) stated that "Habitats apparently include some amount of soil disturbance….I can infer that light man-caused disturbance would not have detrimental effects".

Potential to occur in project area: *Braya glabella* is known from alpine habitat. Priority Treatment Areas for SBEADMR activities would not occur in alpine habitats. *Braya glabella* does not have the potential to occur in the project area or to be impacted by associated activities. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Braya glabella* is approximately 2.2, 1.0 and 2.6 miles respectively for Alternative 2 and 3.1, 1.0, and 4.3 miles for Alternative 3 from any Gunnison Basin North geographic treatment area. Other known *Braya glabella* locations are greater in distance to Gunnison Basin South treatment activity locations (>25 miles).

References: Moore and others 2006. Harris 1985. Warwick and others 2004. Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b.

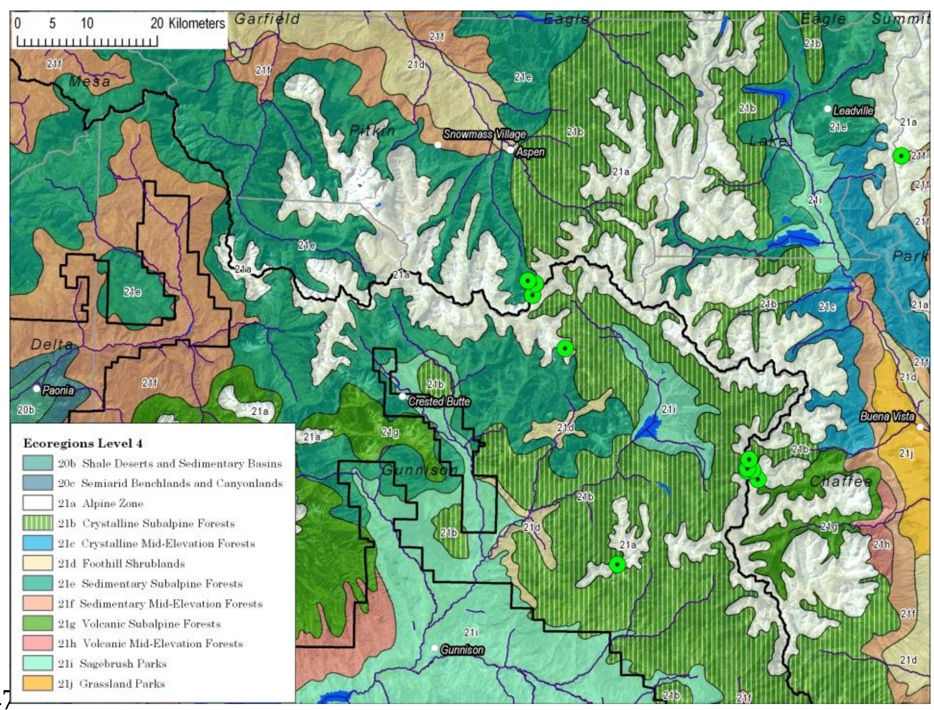


Figure 15. Distribution of *Braya glabella* in or near the GMUG.

Calochortus flexuosus S. Watson. (winding mariposa lily). *Calochortus flexuosus* is tracked by Colorado Natural Heritage Program and globally it is ranked as apparently secure (G4), and as imperiled (S2) in the state of Colorado.

Habitat and Natural History: *Calochortus flexuosus* is a perennial geophyte in the mariposa family (Calochortaceae). *Calochortus flexuosus* may persist for several years awaiting favorable conditions to flower. It is known from dry stony slopes and desert hills between 3,000 and 8,330 feet and may have a preference for alkaline soils.

Range/Distribution: *Calochortus flexuosus* is known from the southwestern states, California, Nevada, Utah, New Mexico and Arizona. In Colorado, *Calochortus flexuosus* is known to occur in Montezuma, Dolores, San Miguel, and Montrose counties in the southwestern part of the state near the Uncompahgre Plateau on the GMUG (Figure 16). This species is not known to occur on GMUG.

Management and conservation issues: The primary threats that have been identified for *Calochortus flexuosus* include habitat loss and grazing, but may also be threatened by invasive plants, oil and gas development, motorized recreation and collection for horticultural use. A large portion of its range is vulnerable to oil and gas development.

Potential to occur in project area: *Calochortus flexuosus* occurs in a habitat type that is not included in the SBEADMR Priority Treatment Areas. *Calochortus flexuosus* does not have the potential to occur in the project area or to be impacted by associated activities. *Calochortus flexuosus* is not in close proximity to any geographic area treatments. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's is from the San Juan geographic area treatment area. It is approximately 18.0, 19.5 and 19.5 miles respectively for both Alternative 2 and 3.

References: Spackman Panjabi and Anderson 2006, Colorado Natural Heritage Program 2013a.

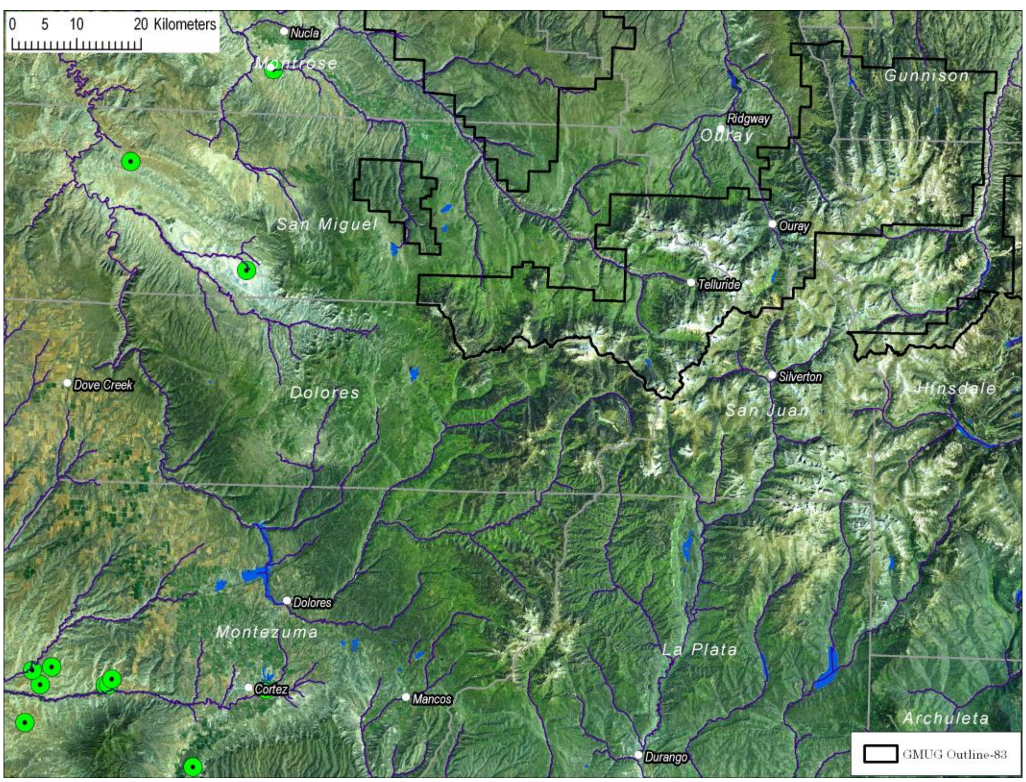


Figure 16. Distribution of *Calochortus flexuosus* in western Colorado (also occurs in Utah, New Mexico). Not known from GMUG.

Carex diandra Schrank. (lesser panicled sedge). *Carex diandra* is tracked by Colorado Natural Heritage Program and is ranked as globally secure (G5) and critically imperiled (S1) in Colorado.

Habitat and Natural History: *Carex diandra* is a densely caespitose, perennial graminoid in the Cyperaceae. *Carex diandra* is found most commonly in montane and subalpine fens, as well as lake margins and wet, often calcareous meadows. The most common habitats described in Colorado and Wyoming are "montane and subalpine fens, particularly those formed in depressions such as small kettles or other basins in periglacial environments…. "The wet and cool environments conducive to fen formation are generally restricted to higher elevations … where cooler and wetter climatic and hydrologic conditions prevail" (Gage and Cooper 2006).

Range/Distribution: *Carex diandra* is a circumpolar species, with a North American distribution from Canada across the northern and central United States. *Carex diandra* is far rarer southward through the Rocky Mountain Region, being restricted to a limited number of sites in the states of Colorado, Wyoming, and Nebraska; there are about fifteen sites for this species in Colorado, two reports from the GMUG (Figure 17).

Management and conservation issues: *Carex diandra* is primarily found in fens, which are wetlands influenced hydrologically and geochemically by groundwater inputs. Activities which have or continue to impact hydrologic functioning of the fens, including road construction, trampling by livestock, recreationists, native ungulates, or motorized recreation have been identified as potential threats to habitat.

Potential to occur in project area: There are fens throughout the planning area for the SBEADMR Priority Treatment Areas. This species is likely to occur. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Carex diandra* is approximately 3, 3, and 5miles respectively for both Alternative 2 and 3 from any Gunnison Basin North geographic area treatment location. There are other known *Carex diandra* locations that have a slightly greater distance to other treatment areas within that San Juan geographic area.

References: Gage and Cooper 2006; NatureServe 2013; Colorado Natural Heritage Program 2013b, Cochrane 2003; University of Colorado Boulder Museum of Natural History 2015.

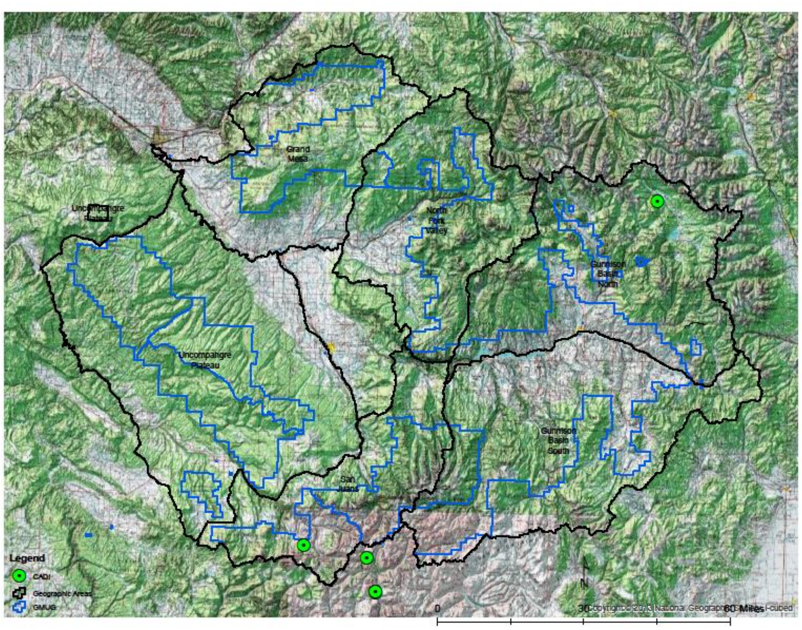


Figure 17. *Carex diandra* in the GMUG and surrounding areas. One population on the Forest has not been fully investigated. There other known location found in Taylor Canyon on the Gunnison Ranger District has been confirmed by the CU Herbarium.

Drosera rotundifolia L. (roundleaf sundew). *Drosera rotundifolia* is tracked by the Colorado Natural Heritage Program, and globally it is ranked secure (G5), however due to geographic isolation this species is ranked imperiled (S2) in the state of Colorado.

Habitat and Natural History: *Drosera rotundifolia* is a carnivorous, perennial herb in the sundew family (Droseraceae). It can reproduce both sexually and asexually, and its carnivorous nature is thought to be an adaptation to the nutrient poor habitats it occurs in, though it does not appear to be restricted by the absence of nutrient availability. *Drosera rotundifolia* is an obligate wetland species that requires continuously moist or saturated soils and is typically found in nutrient poor peatlands at elevations ranging from 9,100-9,800 feet.

Range/Distribution: *Drosera rotundifolia* is widely distributed, occurring throughout much of the Holarctic. In North America it is found throughout Canada and 35 U.S. states. The distribution of *Drosera rotundifolia* closely matches the main distribution of peatlands in North America. Colorado Natural Heritage Program (2013a) lists 18 populations in Colorado; all on National Forests. One population occurs on the GMUG, in an iron fen near Crested Butte in the Elk Mountains (Figure 18).

Management and conservation issues: Threats to *Drosera rotundifolia* include activities that alter the hydrologic function of fens. This includes logging, fires, road building, and activities that divert surface and groundwater flow. They may also be vulnerable to trampling by livestock, recreationists, motorized vehicles and native ungulates. *Drosera rotundifolia* may also be sensitive to nutrient inputs (Nitrogen) from atmospheric deposition or excrement of animals.

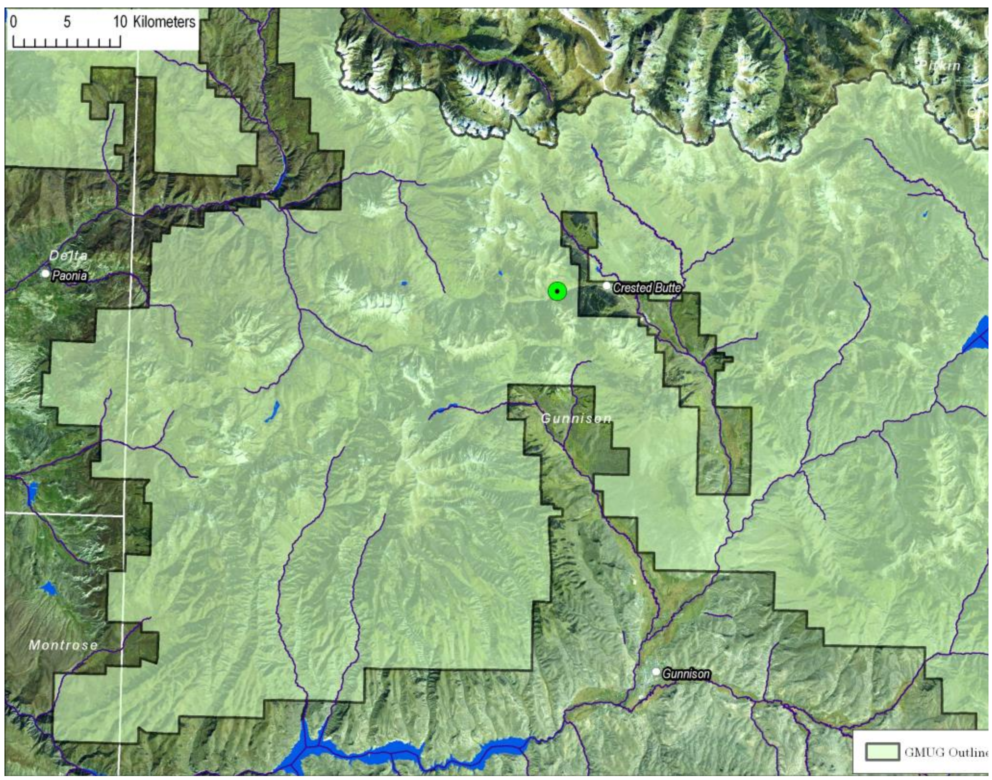


Figure 18. The only population of *Drosera rotundifolia* in or near the GMUG, in an iron fen.

Potential to occur in project area: *Drosera rotundifolia* is known from one population near the planning area for SBEADMR. *Drosera rotundifolia* has the potential to occur throughout the SBEADMR Priority Treatment Areas where there are fens. *Drosera rotundifolia* known location is approximately two miles from the Gunnison Basin North geographic area commercial treatment and three miles from any North Fork Valley treatment locations.

References: Wolf and others 2006; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b.

Epipactis gigantea Douglas ex Hooker. (stream orchid). *Epipactis gigantea* is tracked by the Colorado Natural Heritage Program and is ranked as apparently secure (G4) globally, but imperiled to critically imperiled (S1S2) in Colorado.

Habitat and Natural History: *Epipactis gigantea* requires a constant supply of water and is known from seeps, springs, and perennial streams, and is further described as being found in moist, protected alcoves of sandstone canyon walls. *Epipactis gigantea* is a perennial herb from the orchid family (Orchidaceae) that spreads vegetatively through underground creeping rhizomes. It is known in Colorado to occur at elevations ranging from 4,800-8,000 feet.

Range/Distribution: *Epipactis gigantea* is globally distributed from southern British Columbia through the western United States to central Mexico. Throughout its range it is infrequent but locally abundant. *Epipactis gigantea* is known from the western edge of Colorado, from about 44 populations, though none are known from Forest Service lands (Figure 19).

Management and conservation issues: Maintaining an intact hydrological regime is stated to be the most significant conservation element for *Epipactis gigantea.* Activities that are known to threaten this include recreation, invasive plants, water development, livestock grazing, urban development, timber harvest, and utility line construction/maintenance.

Potential to occur in project area: This species is not known to occur on the GMUG at this time, and has limited potential to occur in the riparian corridors of the Uncompahgre Plateau. It is unlikely to occur in the SBEADMR Priority Treatment Areas, and there are no populations known near roads that could be used as haul roads. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Epipactis gigantea* is approximately 10.5, 6.0 and > 15 miles respectively for both Alternative 2 and 3 from any Uncompahgre Plateau geographic treatment area. There are other known *Epipactis gigantea* locations which have a greater distance to this treatment location and other treatment areas within Uncompahgre Plateau geographic area.

References: Rocchio and others 2006; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b; Weber and Wittmann 2012.

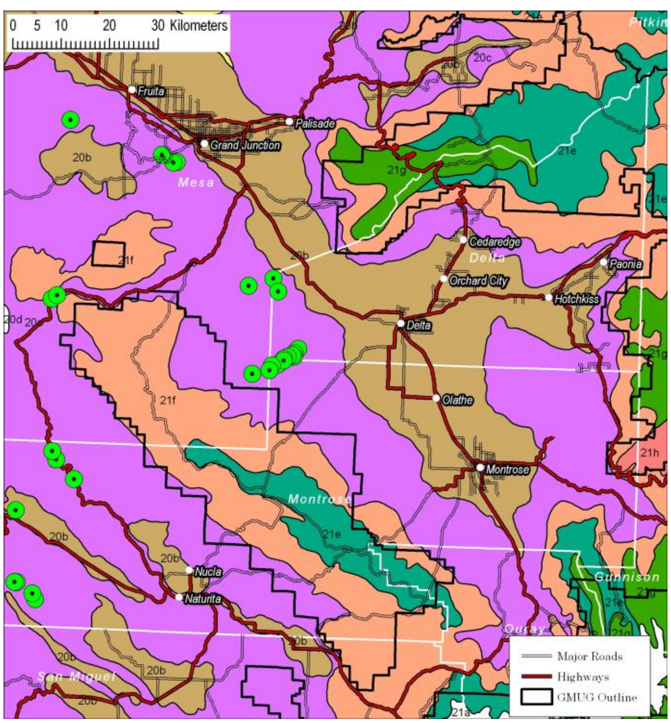


Figure 19. Populations of *Epipactis gigantea* in or near the GMUG. No populations on the Forest.

Eriophorum chamissonis C. A. Meyer. (Chamisso’s cottongrass). *Eriophorum chamissonis* is tracked by Colorado Natural Heritage Program, and is considered to be globally secure (G5), but critically imperiled in the state of Colorado due to its rarity (Colorado Natural Heritage Program 2014).

Habitat and Natural History: *Eriophorum chamissonis* is a perennial graminoid of the sedge family (Cyperaceae). The Rocky Mountain habitat for *Eriophorum chamissonis* is saturated soils in subalpine fens and alpine wet meadows, from 10,400 to 12,000 feet. Sites are often in the upper subalpine zone both below and above timberline.

Range/Distribution: *Eriophorum chamissonis* is a circumpolar species found in Alaska, Canada, the Pacific Northwest and upper Midwest, with disjunct, relict populations in the Rocky Mountains. The USDA Plants database shows Wyoming as the southernmost Rocky Mountain distribution for the species, but according to Decker and others (2006a) there are seven locations in Colorado. Some uncertainties in its distribution have arisen from taxonomic confusion and discrepancies in identification. For example, some Colorado specimens previously identified as Altai cottongrass (which some authors have considered synonymous) have been re-identified as *Eriophorum chamissonis*. There is a single population known in the Elk Mountains, north of Taylor Park on the GMUG (Figure 20), but it expected to occur in other high-elevation fens on the Forest as well.

Management and conservation issues: *Eriophorum chamissonis* grows in fen communities that are vulnerable to changes to hydrology. Other identified threats include grazing, motorized vehicle use, peat mining, fire and global climate change.

Potential to occur in planning area: The Priority Treatment Areas for SBEADMR is within the distributional range for *Eriophorum chamissonis*, and may have suitable habitat for this species. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA’s from any known location of *Eriophorum chamissonis* is approximately 10.0, 4.0 and 10.0 miles respectively for both Alternative 2 and 3 from any Gunnison Basin North geographic treatment area. Other known *Eriophorum chamissonis* locations have a similar distance from the San Juan geographic treatments location

References: Decker and others 2006a; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b; USDA, Natural Resources Conservation Service, 2014.

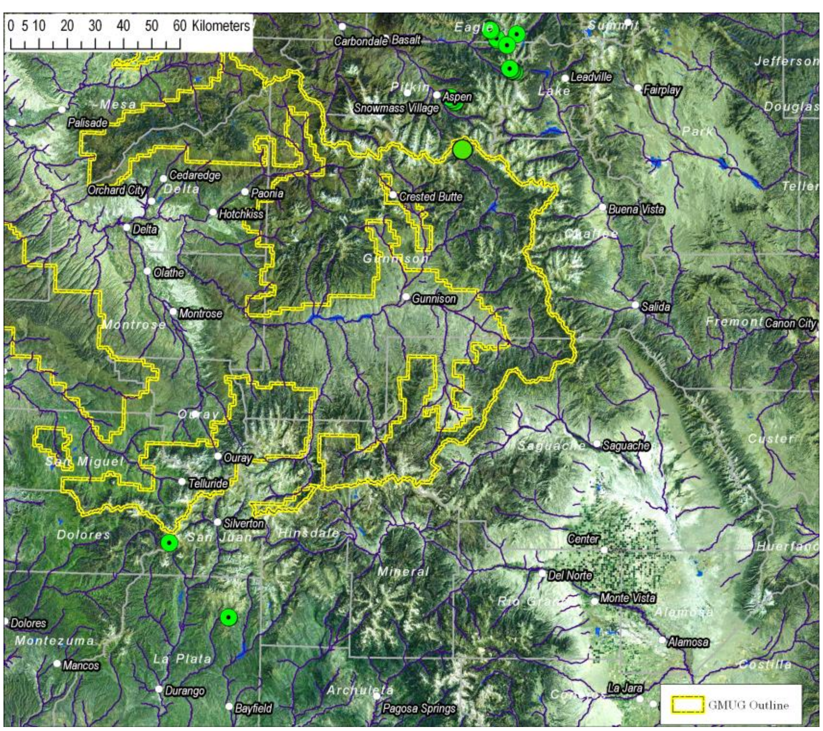


Figure 20. Populations of *Eriophorum chamissonis* in or near the GMUG. The one population on the Forest is in a high-elevation fen.

Eriophorum gracile W. D. J. Koch. (slender cottongrass). *Eriophorum gracile* is tracked by Colorado Natural Heritage Program, and is ranked secure globally (G5) but imperiled in Colorado (S2).

Habitat and Natural History: *Eriophorum gracile* is a perennial graminoid of the sedge family (Cyperaceae). In the Rocky Mountains, *Eriophorum gracile* grows in montane and subalpine wetlands as well as wet meadows and pond edges at elevations of 8,100-12,000 ft.

Range/Distribution: *Eriophorum gracile* is found from Alaska, Canada and the northern states south to California and Colorado. *Eriophorum gracile* reaches its southernmost extent in Rocky Mountain distribution in Colorado, where it is known from Gunnison, Huerfano, Larimer, Jackson, Las Animas and Park Counties. On the GMUG *Eriophorum gracile* is known from the Grand Mesa, Sawatch Range, and the Elk Mountains (Figure 21).

Management and conservation issues: *Eriophorum gracile* is known from rare fen communities which are vulnerable to hydrologic alterations. Grazing, motorized vehicle use, peat mining, invasive species and global climate change, have also been identified as potential threats to *Eriophorum gracile*.

Potential to occur in project area: *Eriophorum gracile* is known from at least three populations in the SBEADMR Priority Treatment Areas, and has the potential to occur in other fens in the SBEADMR treatment opportunity areas. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Eriophorum gracile* is approximately 1.0, 3.0 and 1.7 miles respectively for both Alternative 2 and 3 from any Grand Mesa geographic treatment area. Other known *Eriophorum gracile* locations have a greater distance (5-15 miles) from any Gunnison Basin North geographic area treatment locations.

References: Decker and others 2006b; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b.

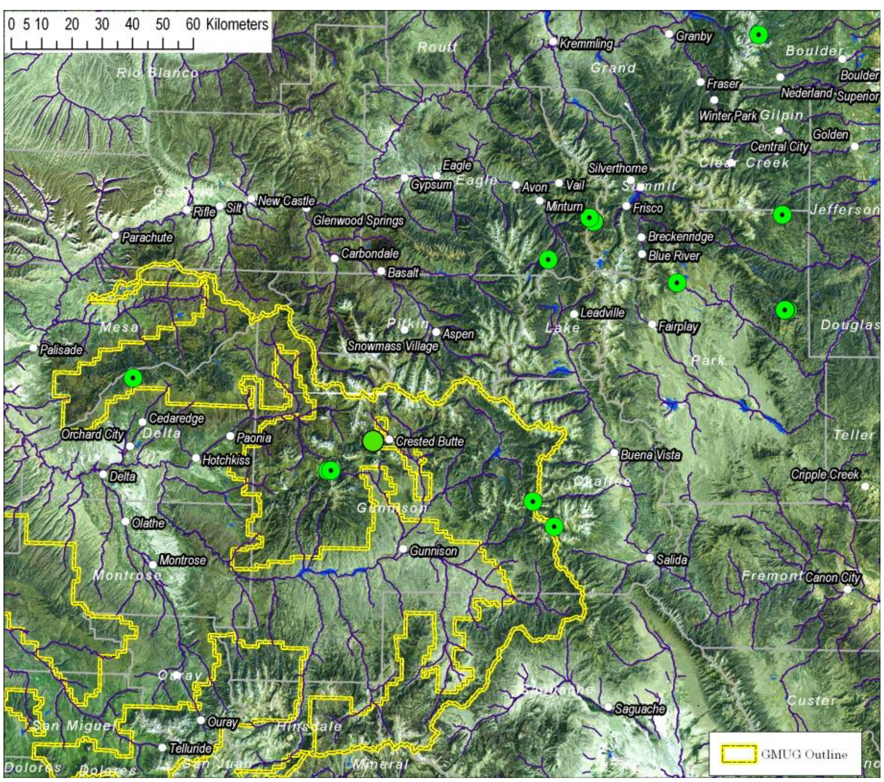


Figure 21. Populations of *Eriophorum gracile* in or near the GMUG. Most populations are in neutral fens.

Kobresia simpliciuscula (Wahlenberg) McKenzie. (simple bog sedge). *Kobresia simpliciuscula* is tracked by Colorado Natural Heritage program and is ranked as globally secure (G5). It is ranked imperiled (S2) in Colorado.

Habitat and Natural History: *Kobresia simpliciuscula* is a perennial graminoid in the sedge family (Cyperaceae). It is capable of both sexual (seed) and vegetative propagation. *Kobresia simpliciuscula* is one of a suite of relictual arctic-alpine species that are often rare because their habitat is rare. It grows in mesic to wet tundra, in shallow wetlands of glacial cirques, and in rich fens.

Range/Distribution: *Kobresia simpliciuscula* is a circumboreal species. In North America it is known from Canada, and seven U.S. states. It is distributed in disjunct population centers in high-elevation alpine areas. Colorado populations have primarily been documented in alpine habitat paralleling the crest of the Continental Divide. There is one population known from the GMUG, found in the Taylor Canyon area (Figure 22).

Management and conservation issues: *Kobresia simpliciuscula* is known to occur in fen communities which are vulnerable to impacts to hydrologic functioning. Other threats include peat mining, grazing and global climate chance. It is also potentially threatened by small, stochastic processes due to the small size of the known populations.

Potential to occur in project area: *Kobresia simpliciuscula* is known from alpine communities which will not be included or affected in the SBEADMR Priority Treatment Areas. *Kobresia simpliciuscula* may also occur in upper subalpine. The only known location is near the Gunnison Basin North geographic area commercial treatment location. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from this known location of *Kobresia simpliciuscula* is approximately 6.4, 3.5and 3.6 miles respectively for Alternative 2 and 9.5, 4.0, and 9.2 miles for Alternative 3.

References: Decker et al. 2006d, Colorado Natural Heritage Program 2013b, Ball 2002; University of Colorado Boulder Museum of Natural History 2015.

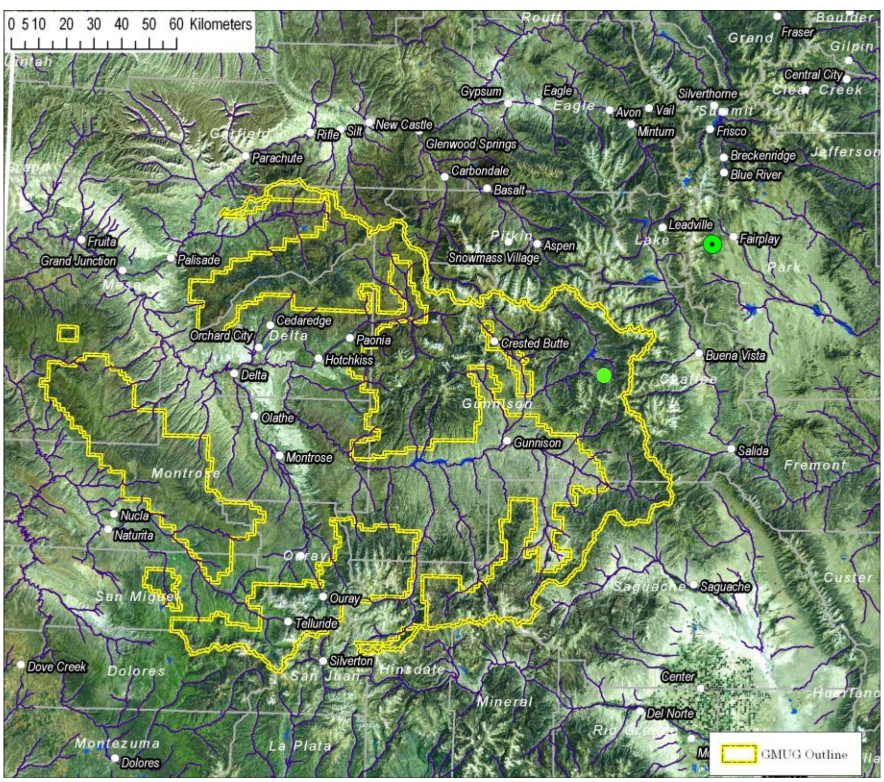


Figure 22. Populations of *Kobresia simpliciuscula* in or near the GMUG. There is one known population on the Forest located in Taylor Canyon (confirmed with CU herbarium).

Machaeranthera coloradoensis (A. Gray) Osterhout. (Colorado tansy aster) *Machaeranthera coloradoensis* is tracked by Colorado Natural Heritage Program, and considered imperiled both globally and in Colorado (ranked G2/S2). This species is also known as *Xanthisma coloradoense* (A. Gray) D. R. Morgan and R. L. Hartman.

Habitat and Natural History: *Machaeranthera coloradoensis* is a low-growing perennial herb of the sunflower family (Asteraceae). *Machaeranthera coloradoensis* inhabits mountain parks, slopes, rock outcrops and dry tundra at elevations ranging from 8,500-12,500 feet. *Machaeranthera coloradoensis* apparently prefers exposed substrates of calcareous, sedimentary, and volcanic origin, and it may rely on periodic natural disturbance to maintain its open habitat.

Range/Distribution: *Machaeranthera coloradoensis* is endemic to Wyoming and Colorado, ranging from southern Colorado to the Medicine Bow National Forest in southeastern Wyoming. In Colorado known populations exist in Chaffee, Gunnison, Hinsdale, La Plata, Lake, Mineral, Park, Pitkin, Saguache, and San Juan Counties. *Machaeranthera coloradoensis* is known from at least 36 populations in Colorado, with approximately half of these on the GMUG (Figure 23).

Management and conservation issues: *Machaeranthera coloradoensis* is vulnerable to threats because of the restricted geographic range. The populations at greatest risk are those lower elevation populations adjacent to, or in roads. Other potential threats include motorized and non-motorized recreation, trail and/or road construction and maintenance, reservoir expansion, housing development, changes to natural disturbance regimes, livestock, and invasive species.

Potential to occur in project area: *Machaeranthera coloradoensis* is known to occur in SBEADMR Priority Treatment Areas, and has the potential for additional populations where suitable habitat exists. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Machaeranthera coloradoensis* is approximately 0.2 for PTA, 0.04 from edge of hazard tree treatment, and 3.0 miles to any new road for Alternative 2. The distance for alternative 3 is 4.0, 2.0, and 4.5 miles from any Gunnison Basin South geographic treatment area. There are other known *Machaeranthera coloradoensis* locations which have a greater distance from Gunnison Basin North (>6 miles) and San Juan geographic area treatment locations (>10 miles).

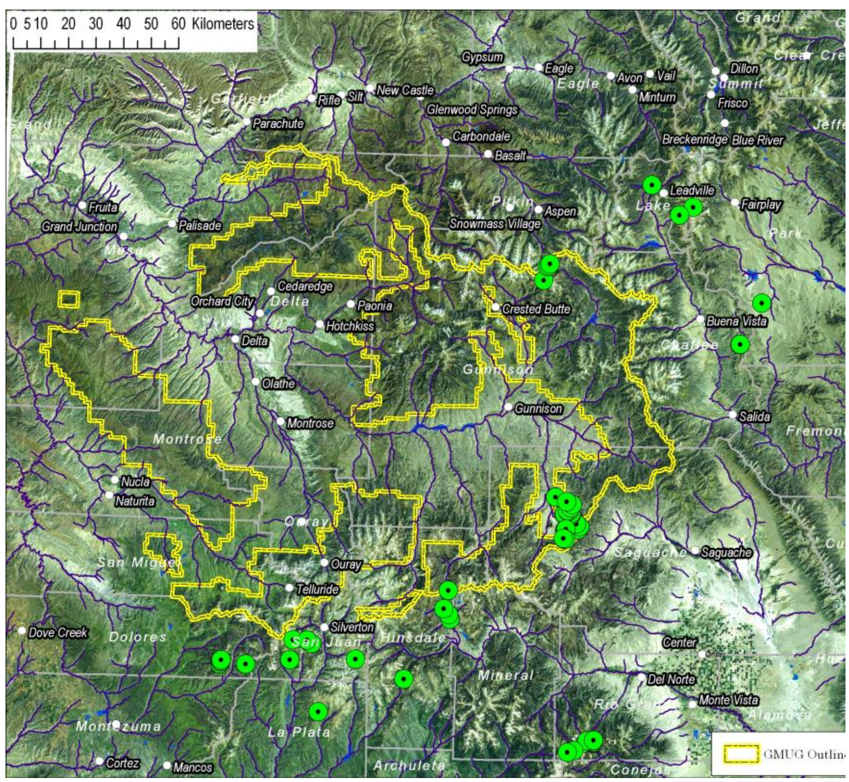


Figure 23. Populations of *Machaeranthera coloradoensis* in or near the GMUG. Populations are in parks and in the alpine, both on calcareous or limy substrates.

References: Beatty 2004; Morgan and Hartman 2003; Hartman 2006; Colorado Natural Heritage Program 2013b; NatureServe 2013.

Neoparrya lithophila Mathias. (Bill's neoparrya). *Neoparrya lithophila* is tracked by Colorado Natural Heritage Program, and is ranked globally vulnerable (G3) and vulnerable at the state level in Colorado (S3). It is probably more properly named *Aletes lithophilus* (Mathias) W. A. Weber.

Habitat and Natural History: *Neoparrya lithophila* is a perennial herb in the carrot family (Apiaceae). *Neoparrya lithophila* is found primarily on late-Tertiary volcanic substrates including dikes, lava flows, and igneous outcrops composed primarily of basalt or tuff. It grows at elevations from 7,000 to 10,000 feet.

Range/Distribution: *Neoparrya lithophila* is endemic to the southern Rocky Mountains. Populations are naturally isolated by the discontinuity of suitable habitat. It is known from Colorado in Chaffee, Conejos, Fremont, Huerfano, Mineral, Rio Grande, and Saguache Counties. Most populations are known from the western rim of the San Luis Valley, and it has not yet been found on the GMUG (Figure 24).

Management and conservation issues: *Neoparrya lithophila* is thought to a degree to be protected by the rugged nature of its habitat, though conversely this makes it challenging to thoroughly survey its habitat. It may be threatened through off-road vehicle use, grazing recreation, mining, timber harvest, development, invasive species, global climate change, and pollution.

Potential to occur in project area: The SBEADMR Priority Treatment Areas do not overlap with the known range, nor the known habitat preference for *Neoparrya lithophila.* The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Neoparrya lithophila* is approximately 6.6, 6.9 and 8.0 miles respectively for both Alternative 2 and 3 from any Gunnison Basin South geographic treatment area. Other known *Neoparrya lithophila* locations have a greater distance from other locations within Gunnison Basin South and Gunnison Basin North treatment locations (>12 miles).

References: Anderson 2004a; Colorado Natural Heritage Program 2013b.

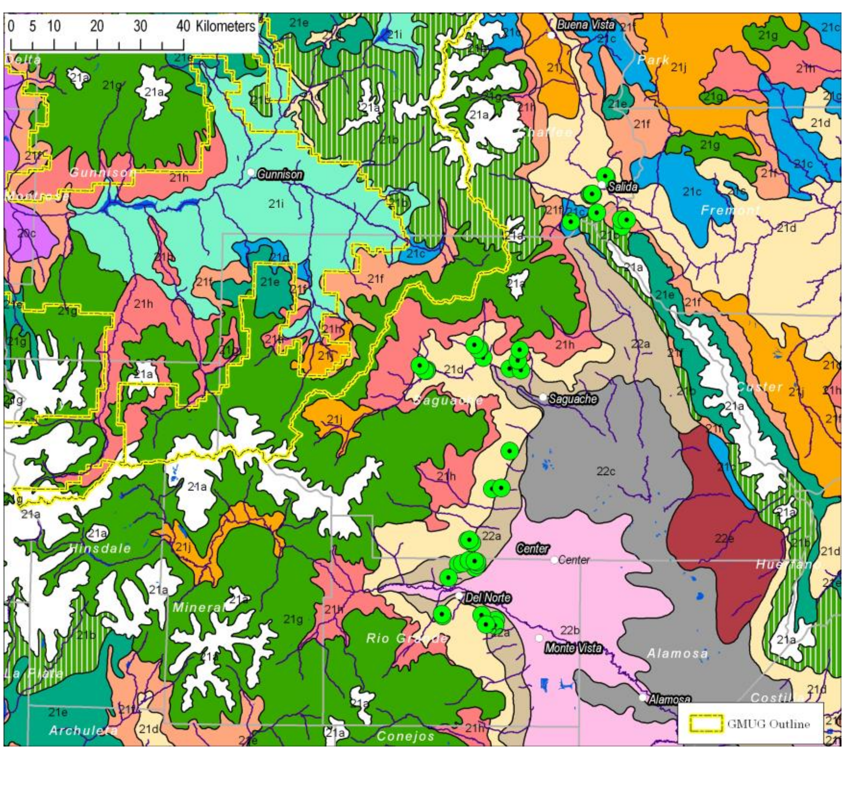


Figure 24. Populations of *Neoparrya lithophila* near the GMUG; no populations on the Forest. This species should more properly be called Aletes lithophilus.

Physaria pulvinata O’Kane and Reveal. (cushion bladderpod). *Physaria pulvinata* is tracked by Colorado Natural Heritage Program, and is ranked globally critically imperiled (G1) and critically imperiled (S2) in the state of Colorado; but no one has yet searched intensively for it.

Habitat and Natural History: This species was described in 2006 and there have not been any studies on the demography and life history of this species, though it has been described as a long-lived perennial. *Physaria pulvinata* has been found on scattered outcrops of grayish, argillaceous shale. It is known from elevations ranging from 7,543- 8,487 feet.

Range/Distribution: This species is currently known from three populations and is thought to be endemic to western Colorado. It is known only from Dolores and San Miguel Counties (Figure 25). *Physaria pulvinata* is not known to occur on the GMUG, or close to it.

Management and conservation issues: The habitat and habitat quality for *Physaria pulvinata* is currently in a downward trend due to extensive human impacts including over-grazing, intense recreational use, and soil disturbance. Soil disturbance has been identified as having the greatest impact as the shale the plant occurs on is mined for road construction and maintenance.

Potential to occur in project area: *Physaria pulvinata* is not known from the GMUG, and is known from a habitat type and range not included in all SBEADMR activities Priority Treatment Areas. *Physaria pulvinata* does not have the potential to occur in the project area or to be impacted by associated activities. *Physaria pulvinata* is not near any geographic area treatments. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA’s is from any San Juan geographic treatment area. It is approximately 18.0, 17.0 and 18.0 miles respectively for Alternative 2 and 21.0, 17.0, and 21.0 miles for Alternative 3.

References: Anderson and Panjabi 2006; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2013b.

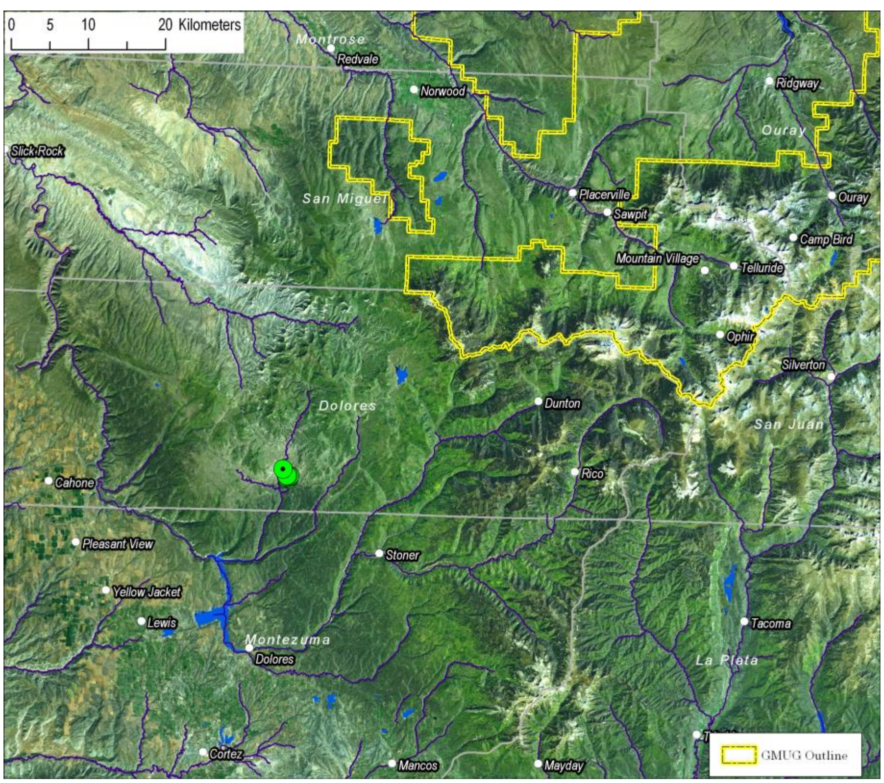


Figure 25. All known populations of *Physaria pulvinata*, fairly far from the GMUG (no code in plants.usda.gov). The species has been recently described, and not all possible habitat has yet been investigated.

Physaria scrotiformis O'Kane. (west silver bladderpod). *Physaria scrotiformis* is tracked by Colorado Natural Heritage Program and is ranked globally critically imperiled (G1) and critically imperiled (S1) in the state of Colorado.

Habitat and Natural History: *Physaria scrotiformis* is a prostrate to decumbent, diminutive perennial in the mustard family (Brassicaceae). It grows in windswept, cobbly to gravelly limestone outcrops in a matrix of *Picea engelmannii* islands and tundra and upper subalpine vegetation. This species is known from a narrow elevation range of 11,555 to 11,834 feet.

Range/Distribution: This species was first discovered in 2006 and is currently known from the upper subalpine-lower alpine zone of West Silver Mesa on the San Juan National Forest. It is thought to be likely to occur only in a limited area within the Weminuche Wilderness Area. It is not known to occur on the GMUG (Figure 26).

Management and conservation issues: *Physaria scrotiformis* is extremely rare and appears to have narrow habitat requirements. The sensitive nature of the alpine habitats makes recovery difficult after disturbance and sensitive to global climate change. *Physaria scrotiformis* may also be threatened by recreational activities, though at this time this is only speculation.

Potential to occur in project area: SBEADMR Priority Treatment Areas will probably not affect *Physaria scrotiformis*, since it is unlikely that that this species occurs within the range of the project, though this species was recently described and not all habitat has been surveyed. The SBEADMR Priority Treatment Areas are not planned in tundra and upper subalpine. *Physaria scrotiforms* is not in close proximity to any geographic area treatments. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's is from any San Juan geographic treatment area. It is approximately 26.3, 25.0 and >26 respectively for both Alternative 2 and 3.

References: Warren and Kratz 2009; O'Kane 2007; Colorado Natural Heritage Program 2013a; Colorado Natural Heritage Program 2014.

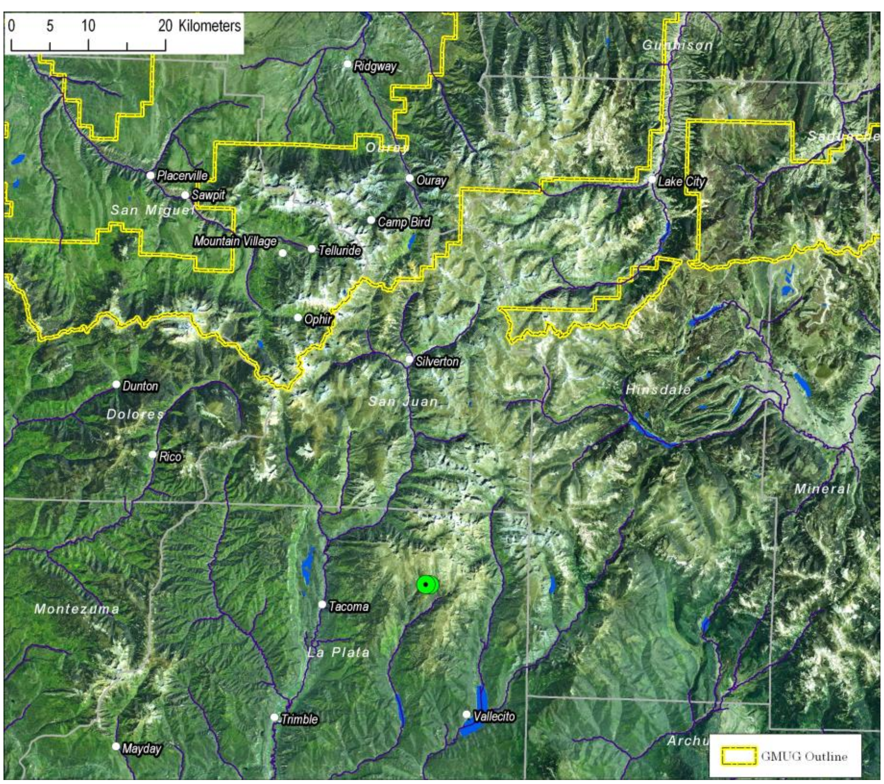


Figure 26. All known populations of *Physaria scrotiformis*, in the alpine of the southern San Juan Mountains (no code in plants.usda.gov). No populations on the GMUG. This species was recently described, and not all possible habitat has been investigated.

Ranunculus gelidus Karelin and Kirilov. Also sometimes called *Ranunculus karelinii* Cherepanov, an erroneous name, or *Ranunculus glacialis* L. var. *gelidus* (Karelin and Kirilov) Finet and Gagnepain. (ice cold buttercup). *Ranunculus gelidus* is tracked by Colorado Natural Heritage Program and is ranked globally as apparently secure to secure (G4G5/S2, but critically imperiled (S1) in the state of Colorado.

Habitat and Natural History: *Ranunculus gelidus* is a small perennial in the buttercup family (Ranunculaceae). *Ranunculus gelidus* is known to occur on rocky alpine ridgetops and saddles, late snowbanks, high alpine peaks, usually in the upper alpine zone, often on calcareous soil.

Range/Distribution: *Ranunculus gelidus* is a widespread species known from arctic regions and high mountain peaks throughout the northern hemisphere, including Asia, Canada, and the United States. In the Rocky Mountain Region, *Ranunculus gelidus* is known from Wyoming and Colorado with limited populations (20-30). On the GMUG *Ranunculus gelidus* is known from two to three populations in the Sawatch Range and San Juan Mountains. There are likely several more additional sites since the species occurs in high-alpine habitats difficult to survey (Figure 27).

Management and conservation issues: *Ranunculus gelidus* is threatened in part due to its small population sizes. In addition, it may be threatened by global climate change, recreation, grazing, invasive species, mining and pollution. Its habitat is often extremely inaccessible and small. They have apparently been stable in size for some decades. Most if not all of these locations are protected by their inaccessibility and rockiness. "These sites would be vulnerable to trails, but these are sites where human use is not very likely, unless the site were the only way to get to some feature, such as a high peak." So far, all sites seen have no trail use.

Potential to occur in project area: SBEADMR Priority Treatment Areas will not affect the upper alpine habitat for *Ranunculus gelidus*. *Ranunculus gelidus* does not have the potential to occur in the project area or to be impacted by associated activities. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Ranunculus gelidus* is approximately 3.4, 0.7 and 3.4 miles respectively for Alternative 2 and 4.3, 0.8, and 4.2 miles for Alternative 3 from any Gunnison Basin North geographic treatment area Other known *Ranunculus gelidus* locations have a greater distance to San Juan geographic treatment locations.

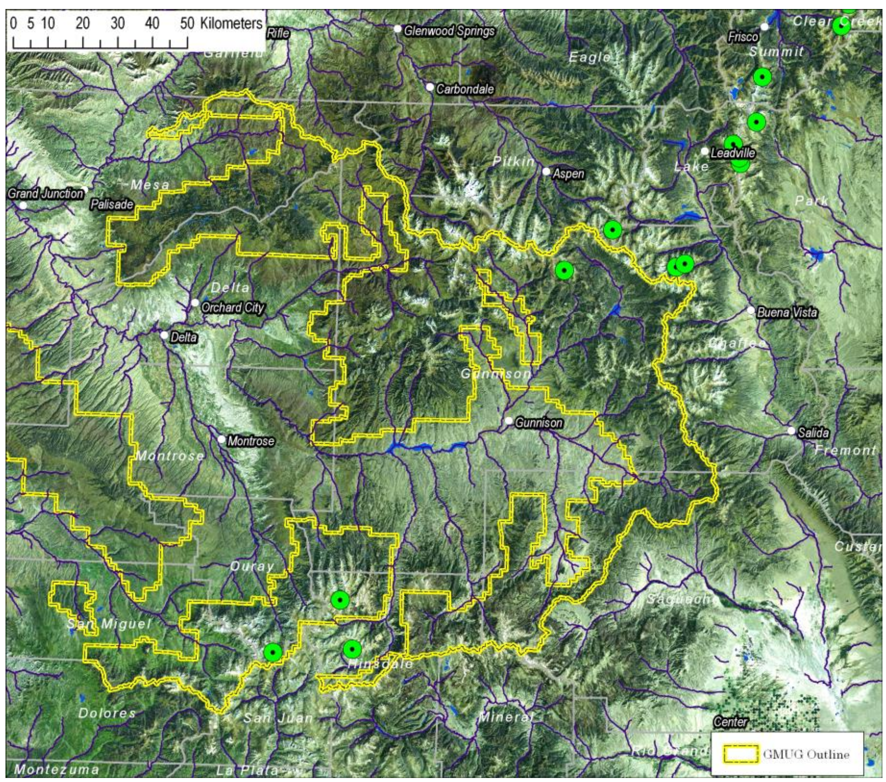


Figure 27. Populations of *Ranunculus gelidus* in or near the GMUG. All are in very cold sites in the high alpine zone.

References: Spackman Panjabi and Anderson 2006b; Colorado Natural Heritage Program 2013b.

Salix candida Flüggé ex Willdenow. (sageleaf willow). *Salix candida* is tracked by Colorado Natural Heritage Program and is ranked as globally secure (G5) but imperiled (S2) in the state of Colorado.

Habitat and Natural History: *Salix candida* is a perennial shrub in the willow family (Salicaceae). Unlike many willows, *Salix candida* does not form larger clones through vegetative propagation, but has seeds that are capable of traveling long distances. Throughout its range it is typically associated with fens, bogs, marshes and other areas of permanently saturated soils where peat is present, and generally fens with higher pH. In Colorado, *Salix candida* is known from elevations ranging from 8,900 to 10,040 feet.

Range/Distribution: *Salix candida* is a boreal species whose distribution is concentrated in the United States and Canada. The populations in the Rocky Mountain Region are disjunct from the main body of its range and are found in Colorado, Wyoming and South Dakota. In Colorado, *Salix candida* is known from 12-15 populations. Three populations are known to occur on the GMUG in the Sawatch Range and the San Juan Mountains, from observations by Colorado Natural Heritage Program personnel in the 1980s (Figure 28).

Management and conservation issues: *Salix candida* grows in calcareous wetlands and fen communities which are vulnerable to alterations in hydrologic function. *Salix candida* is also known to be from small isolated patches that are rare across the landscape. Other threats identified include grazing, road construction and maintenance, peat mining, recreation, alteration of natural fire regime, and invasive species. Any management activities that maintain the natural hydrologic regime of this habitat will contribute to the persistence of *Salix candida.*

Potential to occur in project area: The SBEADMR Priority Treatment Areas fall within the range of *Salix candida* and this species could be present where suitable habitat exists. The closest Priority Treatment Area, hazard tree treatments, or new roads outside PTA's is approximately 1.0, 0.3 and 0.9 miles respectively from any Gunnison Basin North geographic treatment area for Alternative 2 and 7.0, 6.0, and 6.5 miles for Alternative 3. Other known locations of *Salix candida* are >20 miles from San Juan geographic treatment areas.

References: Decker, K. 2006c; Colorado Natural Heritage Program 2013b.

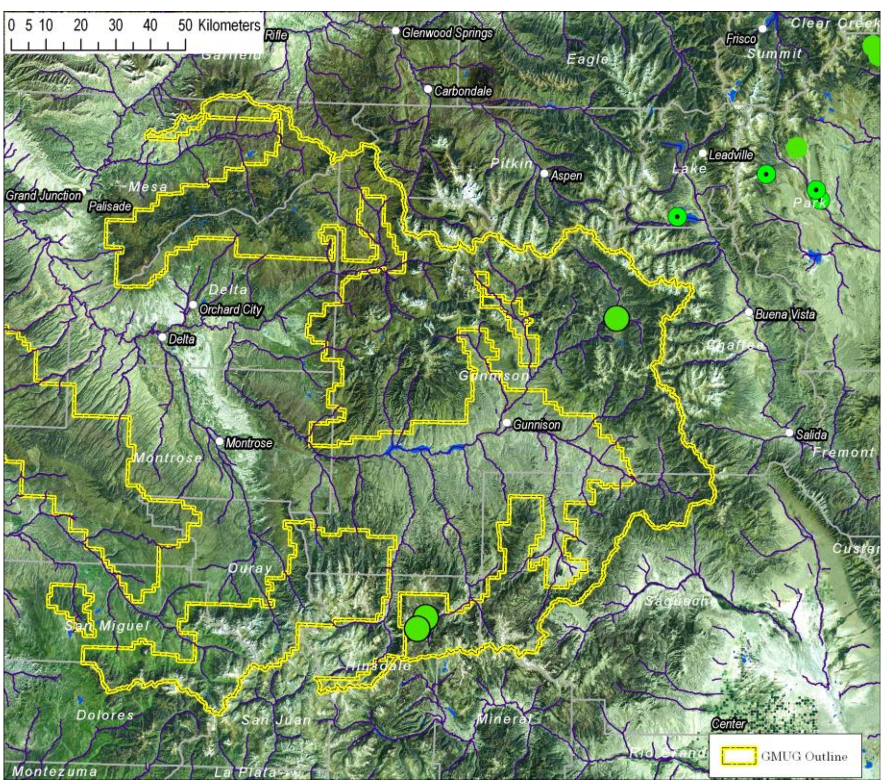


Figure 28. Populations of *Salix candida* in or near the GMUG.

Sphagnum angustifolium (Jensen ex Russow) Jensen. (sphagnum moss). This species is tracked by Colorado Natural Heritage Program, and is ranked as globally secure (G5) and imperiled (S2) in the state of Colorado.

Habitat and Natural History: *Sphagnum angustifolium* is a perennial moss species that grows very slowly. This species is known in Colorado to occur in fens that are considered to be poor (low in nutrients) or iron fens. Rangewide, *Sphagnum angustifolium* is not restricted to this habitat, and is found on rich fens, open mires, sedge fens and muskeg.

Range/Distribution: *Sphagnum angustifolium* is known from Asia and North America. In North America it is known from Canada, and in the U.S. from 28 states. In Colorado, *Sphagnum angustifolium* is known from about ten populations, 2-3 in the San Juan Mountains on the GMUG (Figure 29).

Management and conservation issues: The number of *Sphagnum angustifolium* populations is rare due to the restricted nature of their habitat. Fen habitats are vulnerable to alterations in the hydrologic regime. Other threats identified include motorized vehicular use, pollution, and peat mining. This species is difficult to distinguish from other members of the genus *Sphagnum*, requiring collection and outsourcing for identification. Due to this difficulty, there may be additional population of this species that have been overlooked at this time.

Potential to occur in project area: The SBEADMR Priority Treatment Areas fall within the range of *Sphagnum angustifolium* and this species could be present where suitable habitat exists. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Sphagnum angustifolium* is approximately 4.0, 2.0 and >17.0 miles respectively for both Alternative 2 and 3 from any San Juan geographic treatment area. Other known *Sphagnum angustifolium* locations are >20 miles from the Gunnison Basin North geographic treatment areas.

References: Austin 2007; Colorado Natural Heritage Program 2013b; Encyclopedia of Life 2014, Flora of North America 2014, Crum and Planisek 1988, McQueen and Andrus 2007.

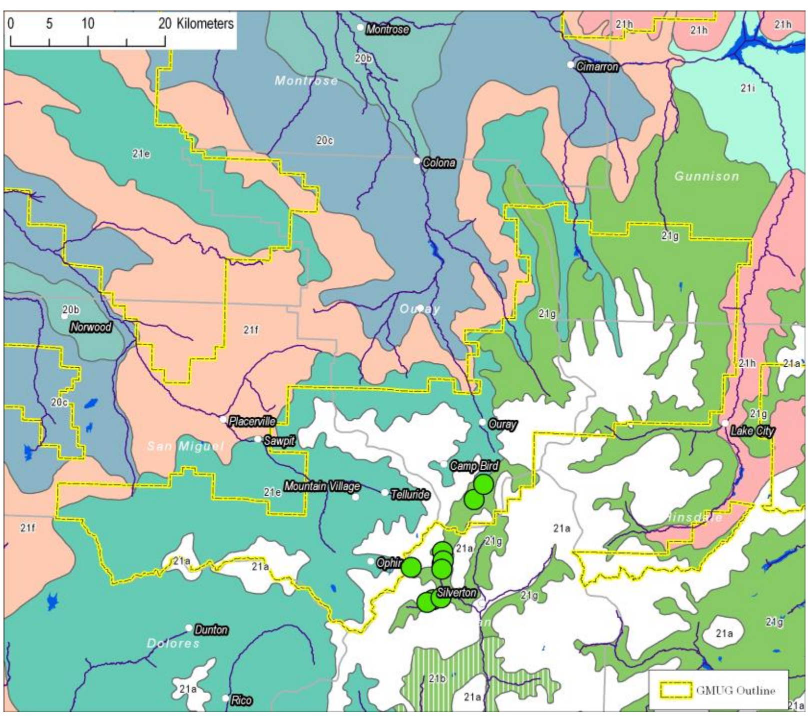


Figure 29. Populations of *Sphagnum angustifolium* in or near the GMUG, all in Subalpine fens. There are probably more populations than these, since the species is difficult to distinguish from other Sphagnum species

Thalictrum heliophilum Wilken and DeMott. (Cathedral Bluffs meadow-rue). *Thalictrum heliophilum* is tracked by Colorado Natural Heritage Program, and is considered to be globally imperiled (G2) and imperiled (S2) in the state of Colorado. This may be a synonym of a larger species, *T. foetidum* L.

Habitat and Natural History: *Thalictrum heliophilum* is a perennial herb in the meadow-rue family (Thalictraceae). Known from open, sunny, barren, steep shale-talus slopes, clay soils derived from the Parachute Creek Member of the Green River Formation. Populations are known from elevations ranging from 6,200 to 8,800 feet.

Range/Distribution: *Thalictrum heliophilum* is narrowly endemic to western Colorado, known only from Garfield, Rio Blanco, and Mesa Counties. There is a single population on the GMUG on Grand Mesa (Battlement Mesa) though there is additional un-inventoried suitable habitat (Figure 30).

Management and conservation issues: Most of the known populations of *Thalictrum heliophilum* are on private lands that are primarily owned by large oil companies where it is threated by oil shale mining, and oil and gas development. It is also thought to be threatened by invasive plants, wild ungulates, and climate change.

Potential to occur in project area: This species occurs in habitat that would not be affected by SBEADMR Priority Treatment Areas. *Thalictrum heliophilum* is not near any geographic area treatments. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's is from any Grand Mesa geographic area treatment area. It is approximately, 12.0, 14.0, and 13.5 miles respectively for both Alternative 2 and 3.

References: Weber and Wittmann 2012; Colorado Natural Heritage Program 2013b Spackman Panjabi and Anderson 2007.

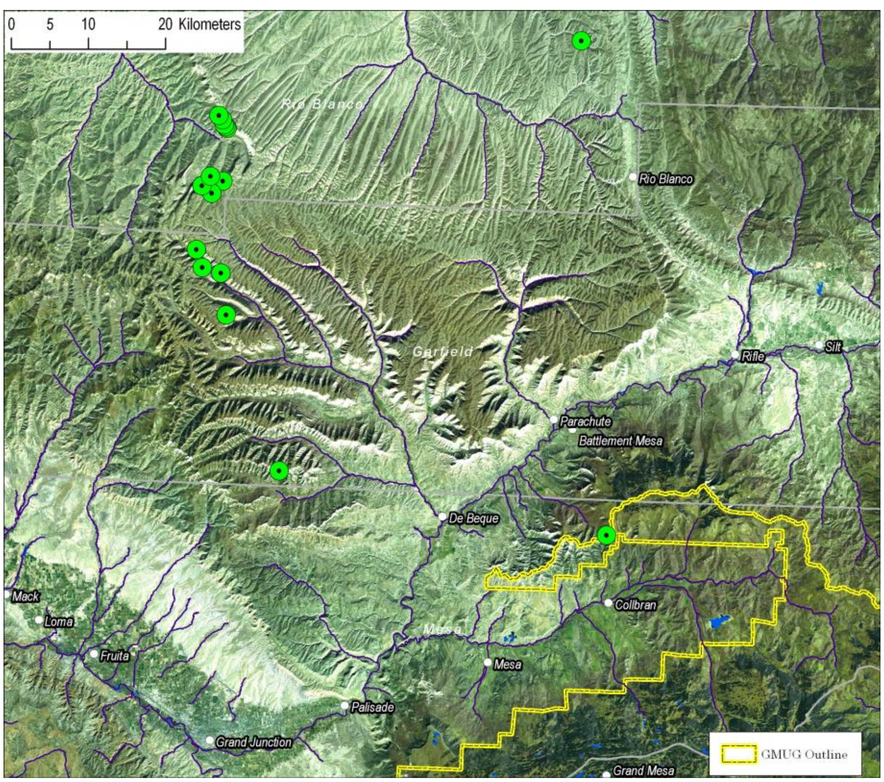


Figure 30. Populations of *Thalictrum heliophilum*. The one population on the Forest is probably marginal, on open sunny shale scree slopes, but there are likely more populations on Battlement Mesa.

Utricularia minor L. (lesser bladderwort). *Utricularia minor* is tracked by Colorado Natural Heritage Program and is ranked as globally secure (G5) but imperiled (S2) in the state of Colorado.

Habitat and Natural History: *Utricularia minor* is a small, perennial semi-aquatic species from the bladderwort family (Lentibulariaceae). *Utricularia minor* is generally associated with montane and subalpine fens and small localized seeps at high elevations. It is a semi-aquatic species, and requires perennial inundation.

Range/Distribution: *Utricularia minor* is a circumboreal species found throughout the northern hemisphere in North America, Europe and Asia. In North America it occurs in both Canada and the United States. In Colorado it occurs in five counties. It is known from several populations on the Grand Mesa, near Crested Butte and in Taylor Canyon on the GMUG (G. Austin, personal communication, 2015; figure 31).

Management and conservation issues: *Utricularia minor* is known to be sensitive to changes in water quality. It is known from fen communities which are vulnerable to hydrologic alterations. Invasive species has also been identified as a management concern for *Utricularia minor. Utricularia minor* is very diminutive in size, and may be underrepresented in documentation due to the ease of overlooking this species.

Potential to occur in project area: *Utricularia minor* is known to occur in Priority Treatment Areas for the SBEADMR project, and has the potential for additional populations where suitable habitat is present. The closest Priority Treatment Area, hazard tree treatment, or new roads outside PTA's from any known location of *Utricularia minor* occurs within the Grand Mesa geographic area treatment location, <1.0 miles from hazard tree treatments, and 1.5 miles from new roads for both Alternative 2 and Alternative 3. There are other known *Utricularia minor* locations in close proximity (1 mile) to the San Juan and (3 miles) from Gunnison Basin North geographic treatment area.

References: Neid 2006; Colorado Natural Heritage Program 2013b, Matsumura and Harrington 1955; G. Austin, personal communication 2015.

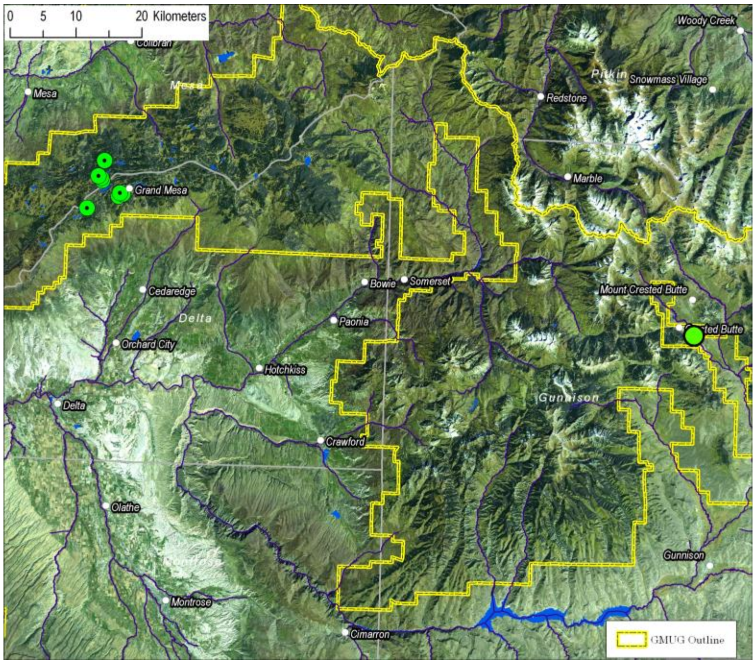


Figure 31. Populations of *Utricularia minor* on the GMUG. Most of these are in fens. There is an additional location found in Taylor Canyon on the Gunnison Ranger District (not shown on the above map).

Species considered for *analysis*

Of the twenty-two sensitive species with the potential to occur on the GMUG, ten were determined to fall within the elevation and distributional ranges of the project alternatives, and to have suitable habitat that could be impacted by any of the alternatives. Species that will be considered in effects analysis include:

Astragalus leptaleus
Botrychium paradoxum
Carex diandra
Drosera rotundifolia
Eriophorum chamissonis
Eriophorum gracile
Machaeranthera coloradoensis
Salix candida
Sphagnum angustifolium
Utricularia minor

Features considered for eliminating a species from consideration from further analysis include:

- Species is outside of the known distributional and elevation range of the areas potentially affected by alternatives (e. g., alpine species, low elevation species)
- Species is not known to occur near roads used for project activities
- Species is known from specific geology and soil types that are not included in any of the SPEADMR alternatives.

The rationale for disposition of each species is summarized and condensed from the above species accounts in the table below (Table 13).

Table 13. Forest Service Sensitive Plant Species Found on the GMUG National Forests and surrounding lands. Rarity status is given for each species as a global (G) and state (S) ranking based on NatureServe (2013) conservation status ranks.*

Scientific Name	Common Name	Status Ranking*	Habitat	Suitable habitat present in project areas?	Discussion and Rationale	Carry Forward for Analysis?
Aliciella sedifolia	stonecrop gilia	G1/S1	High alpine, on white volcanic ash with little to very little vegetation. Elevations from 11,800 to 13,400 ft.	No	Known locations are in alpine habitat. Activities for the SBEADMR project will not occur in the alpine zone	No
Astragalus iodopetalus	Violet milkvetch, purple milkvetch	G2/S1	Oak thickets in pinyon-juniper and ponderosa pine; oak-pinyon forests; sagebrush. Elevations from 6,500 to 7,200 ft.	No	Known locations and suitable habitat are elevationally below the SBEADMR project and occur in different vegetation types; no known sites near potential haul routes.	No
Astragalus leptaleus	Park milkvetch	G4/S2	Sedge-grass meadows, swales and hummocks, and among streamside willows. Elevations from 5,800 to 9,400 ft.	Yes	Potential to occur, especially on the Gunnison District. There is suitable habitat present for all SBEADMR action alternatives	**Yes**
Astragalus microcymbus	skiff milkvetch	G1/S1	Open Wyoming big sagebrush stands, on Precambrian gneiss and granite. 7,800 to 8,300'	No	Known locations are elevationally below project area, in different geology and different sagebrush (big sagebrush).	No
Botrychium paradoxum	peculiar moonwort	G3G4, Not ranked in Colorado	Mesic subalpine mountain meadows dominated by grasses, sedges. Single population in CO known from alpine or subalpine open rocky or grassy sites above 10,500' elevation.	Yes	Known populations are in close proximity to SBEADMR action alternative areas (~45 ft.) and additional suitable habitat is present as well for all SBEADMR action alternatives	**Yes**
Braya glabella	arctic braya	G5T/S1	Alpine on calcareous gravelly soils, Elevations from12,000 to 13,000 ft.	No	SBEADMR action alternatives are below the known elevational range of this species, in very different climate and geological setting, and does not provide suitable habitat.	No
Calochortus flexuosus	Winding mariposa lily	G4/S2	Dry stony slopes and desert hills between 3,000 and 8,330 feet and may have a preference for alkaline soils.	No	SBEADMR action alternatives are above the known elevational range of this species. Suitable habitat for this species would not be impacted by project activities.	No
Carex diandra	lesser panicled sedge	G5/S1	Fens, wetlands, subalpine 9,000-10,500' elevation.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species. Fens and wetlands that are suitable habitat for this species are present in all SBEADMR action alternatives.	**Yes**

Scientific Name	Common Name	Status Ranking*	Habitat	Suitable habitat present in project areas?	Discussion and Rationale	Carry Forward for Analysis?
Drosera rotundifolia	round leaf sundew	G5/S2	Fens, floating peat mats with *Sphagnum* moss, 9,100-10,000' elevation.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species. Fens and wetlands that are suitable habitat for this species are present in all SBEADMR action alternatives.	**Yes**
Epipactis gigantea	Stream orchid	G4/S1S2	Seeps, streambanks, and hanging gardens. Elevations from 4,800 and 6,500 ft. Desert.	No	Low elevation wetlands below SBEADMR action alternatives. Suitable habitat for this species will not be impacted with action activities.	No
Eriophorum chamissonis	Chamisso's cottongrass	G5/S1	Fens, wetlands, 9,500 to 14,000' elevation.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species. Fens and wetlands that are suitable habitat for this species are present in all SBEADMR action alternatives.	**Yes**
Eriophorum gracile	slender cotton grass	G5/S2	Sedge meadows, fens, floating peat mats, saturated soil to shallow water, 8,100 to 12,000 ft. elevation.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species Fens and wetlands that are suitable habitat for this species are present in all SBEADMR action alternatives.	**Yes**
Kobresia simpliciuscula	simple bog sedge	G5/S2	Calcareous fens with hummocks, alpine or subalpine, 8,970 to 12,800 ft. elevation.	No	On the GMUG this species is known only from alpine habitat which will not be impacted by any of the SBEADMR alternative activities.	No
Machaeranthera coloradoensis	Colorado tansy-aster	G2/S2	Gravelly places in mountain parks, ponderosa pine stands, dry tundra, sandstone or limestone, 8,500 to 12,500 ft. elevation.	Yes	Known populations are in close proximity to SBEADMR action alternative areas (~200ft.), and additional suitable habitat is present as well. Populations and suitable habitat in alpine will not be affected by any alternatives.	**Yes**
Neoparrya (Aletes) lithophila	rock-loving neoparrya	G3/S3	Cliffs and breaks of volcanic tuffs, up to 8,700 ft	No	Occurs in both in habitat and at elevations that are not included in the SBEADMR action alternatives.	No
Physaria pulvinata	cushion bladderpod	G1/S2	Scattered outcrops of grayish, argillaceous shale. It is known from elevations ranging from 7,543- 8,487 feet.	No	Occurs in both in habitat and at elevations that are not included in the SBEADMR action alternatives.	No
Physaria scrotiformis	west silver bladderpod	G1/S1	Windswept, cobbly to gravelly limestone outcrops in a matrix of Picea engelmannii islands and tundra and upper subalpine vegetation; elevations from 11,555 to 11,834 ft.	No	SBEADMR Priority Treatment Areas will probably not affect *Physaria scrotiformis*, as it occurs in tundra and upper subalpine habitat, and may not occur within the range of the project.	No

Scientific Name	Common Name	Status Ranking*	Habitat	Suitable habitat present in project areas?	Discussion and Rationale	Carry Forward for Analysis?
Ranunculus gelidus	ice cold buttercup, arctic buttercup, tundra buttercup	G4G5/S2	Rocky alpine ridgetops and saddles, late snowbanks, high alpine peaks, usually in the upper alpine zone, often on calcareous soil.	No	The alpine habitat preferred by this species will not be included or impacted by SPEADMR action alternatives.	No
Salix candida	sageleaf willow	G5/S2	Fens, bogs, marshes and other areas of permanently saturated soils where peat is present, and generally fens with higher pH; elevations from 8,900 to 10,040 feet.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species. Species could occur where suitable habitat exists in treatment areas.	**Yes**
Sphagnum angustifolium	sphagnum moss	G5/S2	Iron fens or wetlands, 9,000-11,500’ elevation.	Yes	SBEADMR action alternatives will occur within the range and distribution for this species. Species could occur where suitable habitat exists in treatment areas..	**Yes**
Thalictrum heliophilum	Cathedral Bluffs meadow-rue	G2/S2	Open, sunny, barren, steep shale-talus slopes, clay soils derived from the Parachute Creek Member of the Green River Formation. Populations are known from elevations ranging from 6,200 to 8,800 feet.	No	The SBEADMR action alternatives are above the known elevational range of this species, and would occur outside of the known suitable habitat for this species. Suitable habitat for this species would not be impacted by project activities.	No
Utricularia minor	lesser bladderwort	G5/S2	Montane and subalpine fens and small localized seeps at high elevations.	Yes	Known populations are present within the SBEADMR action alternative Priority Treatment Areas, and additional suitable habitat is present as well.	**Yes**

*. See http://explorer.natureserve.org/ranking.htm.

No further analysis is needed for species that are not known or suspected to occur within the spruce fir or aspen vegetation types within the proposed Priority Treatment Areas, hazard tree treatment areas, new roads or other areas of influence from this project. Determinations for all other species are found below in the Determination Section.

Environmental Baseline

The primary target habitat for the SBEADMR project is Engelmann spruce-subalpine fir (*Picea engelmannii-Abies bifolia*) and aspen (*Populus tremuloides*) vegetation types. Both spruce-fir and aspen occur as or within a matrix of other vegetation types. Spruce-fir forms the primary matrix systems of the subalpine zone in the Southern Rocky Mountains (Gregg 1963, Colorado Natural Heritage Program 2005, Johnston and others 2001). Aspen is a common constituent in this vegetation type, but also can form homogeneous stands; aspen can also occur in the lower-elevation montane zone (Johnston and others 2001). The species considered in this document generally occur in rare or unusual habitats within the montane and subalpine zones.

The spruce-fir zone, or subalpine zone, is the highest forested zone on these national forests, occurring from around 9,500 ft (2,900 m) elevation to the upper treeline, often called timberline. On these national forests, upper treeline occurs around 11,500 – 12,000 ft (3,500 – 3,650 m), somewhat higher in the south part of the forests and on north-facing slopes (Johnston and others 2001). The subalpine zone is dominated by large, continuous stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies bifolia*); sometimes lodgepole pine (*Pinus contorta*) or aspen (*Populus tremuloides*) will be dominant, but slowly seral to fir and spruce. There are openings and parks within this zone, a few large parks, with big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) or fescue grasses (*Festuca thurberi* or *F. idahoensis*). Riparian areas in relatively undisturbed condition are dominated by one of the smaller willows (*Salix planifolia, S. wolfii, S. brachycarpa*, etc.) and sedges (*Carex aquatilis* etc.). Most of the fens on the GMUG are in the subalpine zone (Johnston and others 2012).

The subalpine zone for the last few decades has seen a great deal of tree mortality. Various root and butt-rot diseases have affected subalpine fir, and beetles, budworms, and dwarf-mistletoe in the Engelmann spruce. Almost all stands in this zone are at least partially dead; a trail through the subalpine will often be blocked by fallen trees, even a few days after a trail crew cleared it. Then in the last decade, spruce beetle has been increasing dramatically, killing whole stands of Engelmann spruce within a few years. This spruce beetle epidemic is the major focus of this project.

The montane zone occurs below the subalpine zone on these forests, between about 8,700 ft (2,650 m) and 10,500 ft (3,200 m). On these national forests, the montane zone is only partially forested, the forested portion dominated by lodgepole pine, aspen, ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*). There are occasional stands of blue spruce (*Picea pungens*). The rest of the montane zone is dominated by big sagebrush, Gambel oak (*Quercus gambelii*), and various other shrublands and grasslands. Riparian areas in relatively undisturbed condition have narrowleaf cottonwood (*Populus angustifolia*), blue spruce, various tall willows (*Salix monticola, S. geyeriana, S. drummondiana*, etc.) and sedges (*Carex utriculata*, etc.).

Many aspen stands in the montane zone experienced significant mortality from sudden aspen decline after a deep drought early in this century (Worrall and others 2008-2010-2013), especially aspen stands at lower elevations and those that had not been treated previously. Aspen decline is projected to continue in tandem with climate change, especially following future droughts (Worrall 2010). The severe epidemic by mountain pine beetle in lodgepole pine that decimated northern Colorado forests during that same period has yet to be seen on these national forests, although mountain pine beetle is present here, mostly in endemic quantities.

Geographic Areas

The spruce beetle epidemic and aspen decline management response project has been divided into six geographic areas within the GMUG forest. They include; Grand Mesa, Gunnison Basin North, Gunnison Basin South, North Fork Valley, San Juan, and Uncompahgre Plateau. A brief summary of vegetation and fire/fuels as it relates to each Geographic Area is as follows.

Grand Mesa

Vegetation

Aspen and spruce-fir cover types each currently occupy 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area.

The large extent of aspen is the result of large scale fires in the late 1800s (Sudworth 1900), that affected most of the Grand Mesa Geographic Area. As a result, the majority of this geographic area is currently in mid seral conditions.

Approximately 84 percent of the forest and woodland cover types are in the mature size class.

The majority of the current forest and woodland vegetation conditions – 91 percent - have dense canopy closures (> 40 percent canopy closure).

There is very little early seral condition in any cover type on the Grand Mesa Geographic Area.

When comparing the compositions of current vegetation cover types to PNV types, there is very close comparison, a further indication that current cover types are predominantly in mature conditions.

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The Grand Mesa Geographic Area, and particularly the spruce-fir and aspen cover types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, and stays moist throughout most fire seasons. Additionally, as mentioned previously, these vegetation types are largely in a mid-seral condition and do not currently have the fuel loading, or fuel structure, to support significant fire behavior or growth.

Though current conditions are not conducive to fire occurrence and growth, many of the spruce-fir stands are maturing, developing closed canopies, exhibiting increased mortality, and are beginning to develop surface fuel loads, as well as understory ladder fuels. The spruce beetle epidemic on the Grand Mesa is currently mild but will have an impact on fuel complexes as additional trees die, fall to the forest floor, and new vegetation grows into the resulting openings. As the natural maturing process, and the impact of beetle kill, continues, the spruce-fir stands will become more flammable on the Grand Mesa.

Most aspen stands currently have limited potential to carry fire, though they are aging and some trees, and even whole stands, are beginning to die and fall, and there is conifer encroachment in many of the aspen understories.

The impacts of climate change to both spruce-fir and aspen could more quickly contribute dying trees, surface fuels, and drying conditions, further accelerating the potential of these vegetation types to support fire.

There is significant Wildland Urban Interface in the Ward Lake area, near Powderhorn Ski Area, as well as in other scattered areas within and adjacent to the spruce-fir and aspen vegetation types on the Grand Mesa.

There is very little early seral condition on the Grand Mesa, primarily as a result of the climatic conditions in the area and the 130+ years since past major disturbances. As many stands mature and become more susceptible to fire it would be beneficial to create patches of early seral vegetation types across the landscape to reduce the potential for, and size of, the inevitable large fires that will occur in the next 50-100 years. Increased early seral vegetation conditions would also be beneficial for the development of young, healthy stands as well as wildlife habitat.

Gunnison Basin N & S

Vegetation

Lodgepole pine is the most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 20 percent of the Geographic Area, and is a component of the species mix on an additional 9 percent of the Geographic Area. Lodgepole pine occurs naturally only on the Gunnison Basin Geographic Area portion of the GMUG.

Aspen is the second most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 14 percent of the Geographic Area, and is a component of the species mix on an additional 13 percent of the Geographic Area.

The large extent of lodgepole pine and aspen is the result of large scale fires in the past (Johnston et al. 2001). As a result, the majority of this geographic area is currently in mid seral conditions.

Current vegetation classification shows approximately 46 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent are in mature size class (mostly in the spruce-fir cover type). As mentioned above, photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists.

The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

There is very little early seral condition in any cover type on the Gunnison Basin Geographic Area.

When comparing the compositions of current vegetation cover types to PNV types, the forest types total percentages are approximately equivalent. The majority of the Geographic Area is in mid seral stages currently dominated by lodgepole pine and aspen, however much of these areas will eventually succeed to spruce-fir and Douglas-fir. The biggest difference occurs in the grass/forb types. Much of the current grass/forb cover type is classified as early seral stages of sagebrush and willow PNV types.

The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The Gunnison Basin, and particularly the aspen and spruce-fir vegetation types, has very low fire occurrence due largely to high elevations, significant snow accumulation at the higher elevations, and cool summers. Additionally, there has been significant natural fires in the 1800s, resulting in many aspen stands that are aging and just beginning to develop the fuel loadings and understories to support fire.

Just over half of the vegetation is in the mature age class, mostly consisting of spruce-fir, and much of this consists of dense, closed canopy spruce-fir. As the spruce-fir ages further there will be an increase in surface fuels and understory ladder fuels. Young spruce-fir is also encroaching into many of the aspen stands. The effects of the current beetle epidemic, which is very widespread and intense in the spruce-fir type in the geographic area, and the potential impacts of climate change, will move both the spruce-fir and aspen vegetation types to a more flammable conditions over the next few decades. There is very little early seral vegetation in the Gunnison Basin.

There are numerous Wildland Urban Interface areas in or adjacent to the Gunnison Basin aspen and spruce-fir types, including Crested Butte, Lake City, and numerous scattered small communities and subdivisions, the Crested Butte ski area, as well as several powerline corridors and communication sites.

Some modeling has shown a significant increase in both future fire occurrence, size, and intensity for the Gunnison Basin due to potential impacts from climate change. In order to increase the landscapes resistance to these kinds of future disturbances there should be an effort put forth to increase the extent and health of aspen stands on the landscape and to break up the rapidly declining spruce-fir vegetation type with earlier seral stages. These efforts would be most effective near Wildland Urban Interface areas in and adjacent to the aspen and spruce-fir vegetation types but there would also be value in scattering treatments across the landscape to create resiliency and to help modify the landscape scale fuels complex, which is rapidly trending toward increased flammability.

North Fork Valley

Vegetation

Aspen is currently the dominant tree species occurring on the North Fork Valley Geographic Area, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area.

The large extent of aspen is the result of large scale fires in 1878 to 1879, with less extensive burning occurring in 1883 to 1885 and again in 1890 to 1892 (Sudworth 1900), that affected the northern two-thirds of the North Fork Valley Geographic Areas. As a result, the majority of this geographic area is currently in mid seral conditions.

Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type).

The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

There is very little early seral condition in any cover type on the North Fork Valley Geographic Area.

When comparing the compositions of current vegetation cover types to PNV types, the forest types and bare areas are approximately equivalent. The biggest differences occur in the grass/forb types; however, much of the current grass/forb cover type is also the early seral stage of forest PNV types. Grass/forb PNV types are classified on only a very small amount (< one percent) of the North Fork Valley Geographic Area.

The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The North Fork Geographic Area, and particularly the spruce-fir and aspen vegetation types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, and stays moist throughout most fire seasons. Additionally, a large portion of the area burned in the late 1800s, resulting in vast aspen stands that have remained relatively healthy, and lack flammability. Much of the vegetation is in a mid-seral stage and is not exhibiting flammability at this time, though with increased spruce beetle activity and the potential impacts of climate change, flammability is expected to increase.

Aspen stands are slowly being encroached on by spruce and fir but due to soil and moisture conditions this process appears to be happening more slowly than in other locations.

There are scattered Wildland Urban Interface areas within and adjacent to the spruce-fir and aspen, in this Geographic Area, though most of them are small.

There is very little early seral vegetation in this Geographic Area. With the extent, and age, of existing aspen there are significant opportunities to maintain healthy aspen, as well as to increase the amount of early seral aspen on this landscape. Limited opportunities also exist for managing for diversity and resiliency in the spruce-fir type. Both of these opportunities would result in both decreased flammability and risk on this landscape, as well as healthier vegetation and improved wildlife habitat.

San Juan

Vegetation

Spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juan Geographic Area.

Grass/forb types and bare/rock each comprise 19 percent of the San Juan Geographic Area. The majority of these types are in alpine areas (elevations > 11,000 feet), with 56 percent of the grass/forb types and 86 percent of the bare/rock occurring at these elevations.

The San Juan Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types.

Approximately 86 percent of the forest and woodland cover types are in mature size classes.

The lack of recent disturbances (fire, insect and disease mortality, harvest) is also reflected in current forest and woodland vegetation conditions – 85 percent have dense canopy closures (> 40 percent canopy closure).

There is very little early seral condition in any cover type on the San Juan Geographic Area. Lack of age data does not allow differentiation between late-mid and late seral conditions in the dominant forest types.

When comparing the compositions of current vegetation cover types to PNV types, the forest types and bare areas are approximately equivalent. The biggest differences occur in the willow and grass/forb types. There is currently less of the willow cover type and more grass/forb types on the landscape that would be expected. These conditions occur in alpine areas and are partly a result of limitations in both the current vegetation and the PNV type data. Additional evaluation is needed to determine if this shift in cover type has a relationship to past management activities, such as livestock grazing.

The trend across all vegetation cover types on the San Juan is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The San Juan Geographic Area, and particularly the spruce-fir and aspen cover types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, is largely north facing, and stays moist throughout most fire seasons. Additionally, as mentioned previously, these vegetation types are largely in a late mid-seral condition and are just beginning to develop fuel loadings and fuel structures that could support significant fire behavior or growth, given seasonal moisture conditions are conducive.

There are several Wildland Urban Interface areas as well as several communication sites and utility corridors, within, and adjacent to spruce-fir and aspen in this Geographic Area, including Telluride, Mountain Village, Ouray, and the Telluride Ski Area, as well as many scattered small subdivisions.

Spruce-fir and aspen stands in this Geographic Area have not experienced disturbance in at least 150-200 years and are mature and dense. As the spruce-fir ages further, increasing mortality can be expected, which will lead to increasing surface fuels, development of ladder fuels (young trees) in the understory, and increasing flammability. With additional spruce beetle mortality and the potential impacts of climate change this increased flammability could be accelerated. Fires that may occur in the future could exhibit extreme fire behavior, high resistance to control, and grow to large size, as was the case with the West Fork and Papoose Fires on the adjacent San Juan and Rio Grande National Forests in 2013. Aspen stands are aging and becoming encroached on by spruce and fir, resulting in a slow increase in flammability. Climate change may accelerate this process by drying stands out, and increasing mortality, and the accumulation of dead material, on the surface.

Some of the Wildland Urban Interface areas could have wildfire risk reduced by rejuvenating aspen stands in areas adjacent to the values at risk. Creating more diverse and resilient spruce-fir conditions in some locations would also have a long term benefit to fire management by reducing landscape scale flammability.

Uncompahgre Plateau

Vegetation

Gamble oak and mixed mountain shrub cover types currently occupy just over a quarter of the NFS lands.

Aspen currently dominates a quarter of the NFS lands.

Conifer forest and woodland cover types (pinyon-juniper, ponderosa pine, spruce-fir, Douglas-fir, blue spruce, lodgepole pine) combined make up 38 percent of the current vegetation cover on the

Uncompahgre Plateau. Lodgepole pine does not naturally occur on the Uncompahgre Plateau, but was planted in the 1960s.

Most of the spruce-fir, aspen, mixed conifer, ponderosa pine, Gambel oak and mixed mountain shrub cover types within the total Geographic Area occur on NFS lands.

Most of the pinyon-juniper, cottonwood, sagebrush, willow and grass/forb cover types within the total Geographic Area occur off NFS lands on either BLM or private land.

Current vegetation conditions are a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66 percent are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).

The lack of fire disturbance that has resulted from approximately 100 years of fire suppression efforts is also reflected in current vegetation conditions. Seventy-one percent of the forest and woodland cover types have dense canopy closures (> 40 percent canopy closure). There are very little early seral conditions in any cover type on the Uncompahgre Plateau. This imbalance is most pronounced in cover types that had a history of more frequent fires, such as ponderosa pine, oak-serviceberry and pinyon-juniper-oak-serviceberry types.

When comparing the compositions of current vegetation cover types to PNV types, it appears that aspen and oak currently occupy more area than would have been expected historically. This is somewhat misleading, however; because aspen and oak are both earlier seral stages to conifer dominated forest types (i.e., spruce-fir-aspen, ponderosa pine-oak), and given time, these deciduous cover types will succeed to conifer cover types.

The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands (Manier et al. Draft 2003). A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

Fire and Fuels

The Uncompahgre Plateau Geographic Area has the highest fire occurrence on the GMUG National Forest. The Plateau is surrounded on 3 sides by low elevation, dry, desert-like conditions and is dominated by drier vegetation types, particularly pinyon-juniper, oakbrush, and ponderosa pine, at the mid-elevations. These vegetation types regularly support wildfires that burn upslope into higher elevation vegetation zones, such as aspen, and occasionally into spruce-fir. Major fire disturbances occurred in the late 1800's resetting a large area of the Plateau back to aspen and other early seral vegetation types.

Fire exclusion since the late 1800's has had a significant impact on the extent and composition of the drier vegetation types, particularly ponderosa pine. Due to fire exclusion, many of the higher elevation ponderosa pine stands have been encroached into by spruce and fir that was previously confined to wetter drainages which were sheltered from fire. There is very little pure spruce-fir on the Uncompaghre Plateau; most spruce-fir contains older aspen from earlier successional stages. The aspen is aging, beginning to die, and is being replaced by the spruce-fir.

Though spruce beetle occurrence on the Plateau is moderate at this time the stands are maturing and increasing beetle mortality, and increasing fuels, in the future is likely. Much of the subalpine fir in these stands has died over the past several years and surface fuels are subsequently beginning to build up at an increasing rate. With the decline of aspen, encroachment of spruce fir into aspen stands and into the more flammable ponderosa pine stands, and increasing beetle mortality, coupled with the potential impacts from future climate change, the Uncompahgre Plateau is becoming increasingly vulnerable to large scale, stand replacing fire.

There are scattered, generally small, Wildland Urban Interface areas, as well as numerous utility corridors and communication sites located throughout and adjacent to the spruce-fir and aspen types on the Uncompahgre Plateau.

Rejuvenation or restoration of aspen stands across areas of the Plateau would be highly beneficial from a fire management standpoint, as well as for wildlife habitat and the future health of aspen itself. Creating more diverse, resilient, spruce-fir stands would also be beneficial for long term fire management.

Sensitive Species on the GMUG by Habitat

For purposes of analysis and description the species considered in effects analysis will be grouped for discussion (Table 14). This approach is useful in this effects analysis as the sensitive species are in varying degrees dependent on some threshold of habitat integrity, or some habitat constituent. This dependence is generally based on some sort of ecosystem process (e.g., disturbance) or physiological preference/adaptation (e.g., high hydrologic needs). When approached from this angle, impacts to the integrity of the habitat can be inferred to be associated with the suitability and sustainability of the habitat for individual populations.

Table 14. Sensitive Species on the GMUG, by habitat.

Habitat	Sensitive Species
Montane parks and alpine	*Machaeranthera coloradoensis*
Moist swales and riparian meadows	*Astragalus leptaleus*
Fens and other wetlands	*Carex diandra* *Drosera rotundifolia* *Eriophorum chamissonis* *Eriophorum gracile* *Salix candida* *Sphagnum angustifolium* *Utricularia minor*
Lightly-disturbed microsites (old roads and road cuts) within or close to mesic coniferous stands	*Botrychium paradoxum*

Past and current activities have altered sensitive plant populations and their habitats. These activities have the potential to cumulatively affect sensitive species. These current and past activities include: fire suppression, livestock grazing, grazing and browsing by native ungulates, timber harvest and thinning, prescribed fire, mining, motorized and non-motorized recreational use, road construction and maintenance, urban development and invasive plant infestation. Some of the effects of these activities that have affected and continue to affect sensitive plants could be reduced vigor or population viability due to trampling by grazers or browsers, changed environmental conditions due to timber harvest, decreased resource availability due to competition with invasive plants, or direct mortality.

Mesic Conifer Stands

Botrychium paradoxum is found in habitats where past disturbance has occurred historically, such as closed roads, old road cuts, lightly-used ski slopes, or regenerating roadside pullouts. Individual plants are often found under the canopy of somewhat taller plants, such as young trees, or more often medium-height to small forbs. Potential habitat could be found within the aspen, spruce-fir, lodgepole, and cool-moist mixed conifer cover types in alpine and subalpine zones. Mycorrhizal relationships are very important, for all *Botrychium* species have a mycorrhizal relationship with soil fungi (Beatty and others 2003). This habitat constituent is the most critical for maintaining suitable habitat for *Botrychium.* The initial stage of life of *Botrychium* is completely dependent on its mycorrhizal relationship with a fungus, as most of the individual plants are underground and the fungus provides the individuals with all of its fixed carbon (Johnson-Groh and Lee 2002). This mycorrhizal relationship continues to be important in the stage of the life cycle where *Botrychium* is able to photosynthesize and produce its own carbon source (Winther and Friedman 2007). On the GMUG, very few spruce-fir stands have been inventoried for mycorrhizal fungi, but these conditions seem to be present in many stands across the national forest. Thus a baseline condition of suitable habitat for these species is difficult to quantify.

Montane Parks

Machaeranthera coloradoensis is found in areas with open exposure and soils in montane parks. In these parks, *Machaeranthera coloradoensis* usually occurs on certain geological formations, tuffs with some tendency toward higher pH, limy in character (Beatty and others 2004). On *Machaeranthera coloradoensis* sites, species cover varies widely, from nearly barren slopes, to *Festuca arizonica* grasslands, to low sagebrush or rabbitbrush shrublands; but the *Machaeranthera* plants always occur in open microsites within those communities.

Machaeranthera coloradoensis also occurs on alpine slopes, again in open microsites and associated with limy geologic substrates (Beatty and others 2004a). This species appears to be somewhat resistant to trampling, since it has been observed in beds of seldom-used roads, and seems to do well in areas frequented by cattle or deer.

Wetlands

Wetlands[4], including fens, are estimated to occupy about 0.4% of the GMUG (Johnston and others 2012), that is, about one in every 223 acres. Few of these wetlands occur associated with a stream, but most are round or oval. In the subalpine and montane zones, wetlands are dominated by obligate wetland plants (Lichvar 2012), which on the GMUG include species such as beaked sedge (*Carex utriculata*), water sedge (*C. aquatilis*), and sometimes one or more willow species.

Use of wetlands on the National Forests, and access to them, is managed by the Forest Service under the Clean Water Act[5] and its implementing regulations, especially the wetland mitigation regulations.[6]

[4] Definition of *wetland* according to U. S. Army Corps of Engineers 1987-2010.
[5] 33 U. S. Code § 1251 and following.

Following these regulations, the Forest Service has issued policies and best management practices nationally (USDA Forest Service 2012) and regionally (USDA Forest Service 2006). In the Forest Service, wetlands are surrounded by a buffer called the *water influence zone* (USDA Forest Service 2006). Since these laws and regulations severely restrict any activities in wetlands and limit activities in the water influence zone around them, activities implementing this project will avoid wetlands. Design criteria have been written for this project that avoids activities in wetlands (Appendix B of the Final EIS).

Moist Swales and Riparian Meadows

Astragalus leptaleus grows in lower elevation riparian areas and subriparian swales, typically sedge-grass dominated meadows, swales and hummocks, and streamsides; its population and distribution is not well known, however.

Riparian and sub-riparian grass-sedge swales occur near streams or stream courses; most of these areas would be included within riparian areas according to the definition in the current Forest Plan (USDA Forest Service 1991), and so would fall under the direction for Management Area 9A in that plan.

The general riparian vegetation types on the GMUG are shown in Table 15.

Table 15. Potential riparian plant communities expected to occur on the Grand Mesa-Uncompahgre-Gunnison National Forest (Johnston 1994). See Appendix B within this document for explanation of names.

GMUG Group	Potential Vegetation Classes on the GMUG	Subformation*	Dominant Class†
	FORESTS		
F1	Canyon Cottonwood – Box-Elder	24B. Canyon Cottonwood-Box-Elder	*Fraxinus anomala, Negundo aceroides, Populus deltoides* ssp. *wislizenii, Salix exigua*‡, *S. gooddingii*
F2	Narrowleaf Cottonwood	24A. Narrowleaf Cottonwood	*Crataegus rivularis, C. saligna, Populus angustifolia, P. × acuminata, P. balsamifera*
F3	Blue Spruce Riparian	20G. Blue Spruce Riparian	*Picea pungens, Swida sericea*‡
F4	Spruce-Fir Riparian	22B. Spruce-Fir Riparian	*Abies bifolia – Picea engelmannii, Psychrophila leptosepala*‡, *Cardamine cordifolia, Mertensia ciliata, Swida sericea*‡
	SHRUBLANDS		
S1	Foothills Birch-Alder	17A. Foothills and Plains Shrub, 17B. Montane Alder	*Betula fontinalis*
S2	Montane Maple-Dogwood-Honeysuckle	17C. Montane Maple-Dogwood-Honeysuckle	
S3	Montane Tall Willow	17D. Montane Willow	*Alnus incana* ssp. *tenuifolia, Salix bebbiana, S. boothii, S. drummondiana, Salix exigua*‡, *S. geyeriana, S. ligulifolia, S. lucida* ssp. *caudata, S. lucida* ssp. *lasiandra, s. monticola*
S4	Subalpine Short-Willow – Birch	17E. Subalpine Birch, 17F. Subalpine Willow	*Betula glandulosa, Salix brachycarpa, S. glauca, S. planifolia, S. wolfii*
	HERBACEOUS		
H1	Foothills Marsh Wetlands	(none)	*Typha* spp.
H2	Tufted Hairgrass and Reedgrass	11A. Tufted Hairgrass and Reedgrass Wet Meadows	*Calamagrostis canadensis, Deschampsia cespitosa*
H3	Wetlands	11B. Wetlands and fens	*Carex aquatilis, C. nebrascensis, C. pellita, C. utriculata, Eleocharis palustris, E. quinqueflora*, etc.
	ALPINE		

[6] 33 Code of Federal Regulations 325-332 and 40 CFR 230; see Federal Register 73(70):19594-19705 of April 10, 2008.

A1	Marsh Forblands	27. Marsh Forblands and Late Snowmelt Areas	*Psychrophila leptosepala*‡, *Carex praeceptorum, C. scopulorum*

*. After Johnston 1994. †. Kittel and others 1999, Johnston and others 2001, Graham and Renner 2004. ‡. In part.

National and regional best management practices include buffers around streams, called *water influence zones* (USDA Forest Service 2006-2012). The water influence zone is a minimum of 100 feet on either side of a perennial stream, usually expanded to include the distinctive riparian vegetation and often the floodplain as well (WQSP-2A, Appendix B of the Final EIS). It is likely that populations of *Astragalus leptaleus* would occur within the water influence zone.

There are special restrictions on use of water influence zones, especially with road construction and other activities involving heavy equipment. It is not known how large the populations of *Astragalus leptaleus* are, but seems likely they are fairly small in extent, and so would be relatively easy to avoid by activities planned in this project.

Fens

Fens are "wetlands with waterlogged substrates and approximately 30 cm or more of peat accumulation" (Chadde and others 1998, also see Johnston and others 2012). Fens are "Characterized as having water tables near the soil surface with little annual variance and short periods with deeper water tables" and "the surficial accumulation of ≥20 cm of peat and the presence of common fen species" (Driver 2010, Vitt 2000). Fens are types of peatland, that have been characterized for the GMUG as having 30 cm of peat in the top 80 cm, and anaerobic conditions where peat is accumulating (Johnston and others 2012). Fens are hydrologically dependent on groundwater discharge, and generally experience saturation to soil surface (Bedford and Godwin 2003). Acidic fens (also referred to as "poor fens") are generally dominated by bryophytes with scattered vascular plants.

Seven of the sensitive species considered in this document are known to occur in fens (*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium*, and *Utricularia minor*). *Drosera rotundifolia* and *Sphagnum angustifolium* are known to prefer acidic fens. Neutral to alkaline fens (also known as "rich fens") and generally dominated by vascular plants, primarily sedge species (Chadde and others 1998). *Carex diandra* and *Salix candida* are known to occur primarily in rich fens.

A fen inventory was conducted 2009-2010 on the GMUG. Photointerpretation was used to delineate potential fens. Areas were randomly selected for sampling across the Forest, and a series of biological and physical data were collected. This study estimates that there are approximately 1,738 fens across the GMUG covering 11,034 acres, with half of them being less than four acres in size. Fens on the GMUG are concentrated in the Grand Mesa, Sawatch Mountains and San Juans, and most are known to occur between the elevations of 9,000 to 11,900 feet. This inventory also rated fen condition, finding 81% of the fens in "high" condition, 18% in moderate condition, and 1% in low condition. Fen communities are very sensitive to hydrologic alterations, and once functioning has been impaired, restoration may be possible but is a lengthy and expensive process. A study in the San Juan Mountains found iron fens and sloping rich fens to be the most likely to be in poor condition due to mining and terracing respectively (Chimner and others 2010). The primary factors on the GMUG that are known to be causal agents of degradation or disturbance in and adjacent to fens are browsing and grazing, historic mining activities, roads and trails, flooding, and beaver activity. The lowest scored condition class fens were highly altered by flooding from adjacent reservoirs, historic mining and grazing activities (causing channelization and hence dewatering), all activities that alter the hydrologic functions of the wetland.

The recommended buffer around fens is a minimum of 100 feet from the outer edge of the wetland complex which defines the water influence zone for fens (WQSP-2A, Appendix B of the FEIS). Fens are usually considered irreplaceable (unlike some other kinds of wetlands), because the peat in fens accumulates at such a slow rate (U. S. Fish and Wildlife Service 1999, USDA Forest Service 2011a). For these reasons, Forest Service policy is to conserve or restore fens (USDA Forest Service 2011b).

On the GMUG, fens occupy about 0.14% of the landscape, that is, about one acre in every 715. Fens are small to very small features. As mentioned above, policies and best management practices nationally (USDA Forest Service 2012) and regionally (USDA Forest Service 2006) severely restrict any activities in wetlands (including fens) and limit activities in the water influence zone around them, activities implementing this project will avoid fens.

ANALYSIS AND DETERMINATIONS OF EFFECTS ON SENSITIVE SPECIES

Methodology

The following analysis is based upon professional knowledge, the best available science, and existing best available information.. Effects are analyzed for known occurrences and for potential habitats which will be discussed in the context of occupied habitats. As the main difference between the alternatives is the spatial area that they could occur in, a comparison of Priority Treatment Areas, hazard tree treatments, and new roads that are outside PTA's (all three activities together will be referred to as "potential affected areas") will be a proxy for magnitude of impacts. Commercial and/or non-commercial treatments will be applied within identified treatment areas only. Commercial treatments include; resiliency (<40% overstory mortality), recovery and resiliency (>40% and <90% overstory mortality), and recovery (>90% overstory mortality). Non-commercial treatments include; burn/mechanical and burning. Road construction and re-construction are only associated with commercial treatments.

Scope of Analysis

This project uses the potential affected areas to indicate areas on the GMUG where these activities could occur. The potential affected areas are assessed spatially by Geographic Area of occurrence (Grand Mesa, Gunnison Basin North, Gunnison Basin South, North Fork Valley, San Juan, and Uncompahgre Plateau). Although it is unknown where actions will occur on the ground, treatment types have been identified along with estimated acres associated with each action in each treatment area. Based on current stand conditions and alternative we expect 7-15% salvage, 47-49% variable retention regeneration (combination), and 38-44 % resiliency treatments. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. This ladder scenario is also analyzed and is referred to as "adapted treatment type".

Assumptions Made

There are assumptions we used, that relate to the alternatives considered in this document and their effects on sensitive plant species.

- Use of the design features we recommend in implementation will minimize or reduce direct and indirect impacts (Appendix B of the Final EIS).
- The action alternatives have areas common to all; where these alternatives overlap, the impacts and effects to sensitive plant populations will be identical.
- Fens, meadows, and riparian areas will not have pile burning, heavy machinery, vehicle traffic, or timber harvest occurring in them;
- It is assumed that the types of impacts that have the potential to affect sensitive species are the same to all action alternatives. The effects will be dependent on the location where the treatments occur and whether there are sensitive species present or potentially could occur.

Criteria used to determine impacts

The following criteria were used to determine whether sensitive plant species would be affected by project implementation:

- Whether the species occurs or has the potential to occur within the treatment area;
- Whether design features were included in the proposed action that would eliminate or minimize impacts to sensitive plant species;
- The likelihood of impacts to suitable habitat;
- The nature and extent of impacts anticipated as a result of each alternative;
- The life cycle of the species present or potentially present, and the resulting anticipated response to disturbance;
- The existence of or potential for other impacts to sensitive plant species within the cumulative effects analysis area.

Cumulative effects

For the purpose of this analysis, cumulative effects are bound in space by the Forest Boundary. Cumulative effects will be bound by 10-12 years because this encompasses the life of the project.

ALTERNATIVE 1: NO ACTION ALTERNATIVE

With the no action alternative, spruce-fir mortality and aspen decline are anticipated to continue relatively unmitigated. The actual trajectory of mortality is not predictable, but it is assumed that in the spruce-fir, unless some carrying capacity for the beetles is reached they will continue to move into uninfested areas and kill first large diameter trees, than move to the smaller diameter trees. It is also assumed that aspen will continue to decline, and may experience sudden periodic decreases as were seen with the recent sudden aspen decline epidemic. These events will result in overstory mortality in both spruce and aspen stands. In spruce stands, dead trees will mostly remain standing for several decades[7], but in dead aspen stands, there will be high levels of down trees in the forest.

[7] Roy Mask, personal communication.

Scientists are divided on whether a large-scale spruce beetle epidemic (such as we are experiencing) increases fire risk. However, a spruce beetle epidemic does make fire-fighting more hazardous, which means that fires in beetle-killed spruce will be larger and more often out of control. That many of our spruce stands are in wilderness and roadless areas exacerbates this situation, because motorized fire-fighting equipment is often restricted or disallowed in those areas. This situation could result in passive indirect effects to sensitive plant species. Because one goal of the action alternatives is to reduce the likelihood of high severity wildfire, it is assumed that without the proposed actions, there would be an increased risk of high severity wildfire.[8]

Recent large wildfires in southwestern Colorado have coincided with periods of drought, which will be more unpredictable and more severe as the climate changes (White and others 2013, Williams and others 2012). More severe drought periods will increase the likelihood of severe fires in the spruce-fir zone (Allen and others 2010), and greater likelihood of episodes of sudden aspen decline (Carnicera and others 2011, Worrall and others 2013).

This situation could adversely affect all sensitive species by increasing interspecific competition, habitat loss, and indirect habitat loss due to increases in invasive plants. With abundant biomass, both standing and on the ground, resulting severe wildfires could result in areas with lethal soil heating which would adversely impact any sensitive species that was present, but also could impact vigor of populations by impacting mycorrhizal relationships (especially with *Botrychium* species).

Intense ground heating from severe wildfires usually results in conditions causing major erosion events (Robichaud and others 2000, Peppin and others 2010, Johnston 2012), potentially causing sedimentation events in fens. Sedimentation in fens retards (or even stops) the peat formation process (D. Weixelman, personal communication 2014), changes community structure and could cover, or bury sensitive plants. Lethal soil heating could also result in the direct mortality of individuals or populations or seed or spore banks.

Any beneficial passive impacts that wildfire might have on disturbance niche species such as *Machaeranthera coloradoensis* and *Botrychium. paradoxum*, would be overcome by the soil and habitat loss following severe wildfires. These species appear to be stimulated by varying degrees of disturbance and reduced overstory cover. The relationship between specific coverage and optimal vigor is not known for these species, but given their known habitat, high severity fire would likely result in extensive soil and ground cover loss, and removal of too much of the overstory, resulting in adverse impacts.

The primary difference with wildfire in spruce beetle-killed stands that would affect sensitive species is the increased intensity and residence time of fire on the soil (Robichaud and others 2000-2006, A. Reiner, S. Williams, personal communication 2014). Analysis of the potential effects of high severity wildfire will thus be assessed in the analysis of the No Action Alternative, but while these effects are assumed to be more likely with No Action, no alternative eliminates this risk. There is a small risk to this passive effect.

[8]While the risk of the effects of catastrophic wildfire are common to all alternatives, they will be assessed first in the discussion of the “No Action” alternative, as these impacts are assumed to be somewhat more likely in the absence of proposed fuels treatments associated with the action alternatives.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

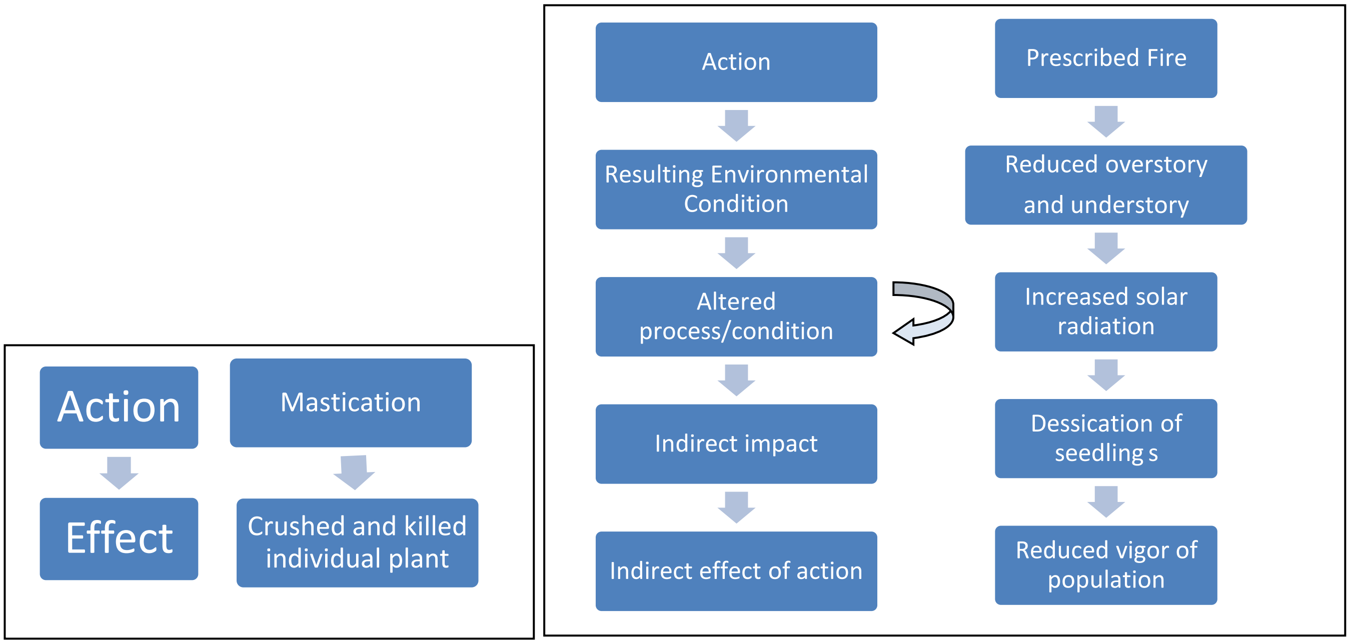
The primary goal of this portion of analysis is to present the range of potential impacts to sensitive species and their habitats. The information is presented in the following order:

a. Activities are identified from the action alternatives that have the potential to impact species populations or suitable habitat.
b. Pathways for direct and indirect impacts are analyzed with emphasis on environmental conditions after planned activities.
c. Analysis of the potential pathways for impacts and subsequent effects as a result of the activities associated with the action alternatives. Analysis of the resulting environmental conditions and the pathways of impacts to individual plant reproduction, survival, and vigor and suitability of habitat.
d. Design feature to minimize the impacts and hence decrease the effects of project associated activities.

Activities were identified from the action alternatives that have the potential to create environmental effects that may impact sensitive species or their habitats. These activities include:

- Increased vehicular traffic and moving of heavy equipment
- Creation and use of staging areas and landings
- Prescribed fire, ground ignition or aerial ignition, including pile burning
- Fireline construction
- Mastication (including chipping)
- Mechanical timber harvest, including site preparation
- Replanting trees and revegetation of new and reconstructed roads
- Road construction, reconstruction, and maintenance
- Road decommissioning
- Treatment of invasive plants
- Dust abatement
- Non-mechanical hand treatments for hazard trees or fuels reduction.

This analysis considers management activities of all action alternatives and associated design features as set forth in the SBEADMR Environmental Impact Statement (Appendix B of the Final EIS). Impacts to plants can be a direct result of the action (see Fig. 32A below) or may result in a changed environmental condition that alters a biological or physical process that results in an indirect impact to the individual species (see Fig. 32B below).



A B

Figure 32: A. Pathway of effects for direct impacts. B. Pathway of effects for indirect impacts.

Both direct and indirect impacts can result in adverse or beneficial effects that ultimately affect the overall capacity of the species to persist as an individual plant, as a single population, a group of populations in a local area, or as a biological entity. Detailed analysis of the actions and the potential range of direct and indirect effects can be found in Appendix A of this document.

Resulting environmental conditions that could lead to impacts (adverse or beneficial) to sensitive plants or their habitats have been identified for the action alternatives based on anticipated project-related activities (Table 16). The activities associated with the action alternatives can result in similar resulting conditions, for example, both hand thinning and mastication would result in somewhat different levels of soil disturbance (Appendix A of this document). The magnitude of the resulting condition and hence the magnitude of anticipated indirect or direct impacts will vary from different methods of treatment and project associated activities.

Table 16. Environmental conditions that result from activities associated with the action alternatives.

Resulting Environmental Condition	Notes
Introduction or increase in invasive plants	
Soil disturbance	Beyond normal levels. Includes erosion, movement or removal of soil, alteration of hydrologic systems, and dust
Air pollution	
Water pollution	Runoff from roads into streams, riparian areas, and wetlands
Soil compaction	
Hydrological alteration	Dams, ditches, culverts, other water-control structures
Toxicity	Includes chemical spills
Removal or damage of vegetation	Including overstory and understory trees, shrubs, or herbaceous vegetation
Alteration of successional pathways	
Removal of ground cover	Including mosses, lichens, litter and duff, gravel, stones and boulders
Soil heating	From prescribed fire
Changes in fuel quantity or quality	Physical alteration of biomass or fuels profile (increased fuels on ground)
Fragmentation or isolation of stands in landscape	Stands could be stands of trees, openings, shrub communities, or herbaceous communities

The following is a detailed discussion of the actions, the resulting environmental conditions, and the direct and indirect effects to sensitive plant species.

Direct Effects

New or temporary road construction results in localized, but intense soil disturbance that leaves the road bed and banks devoid of previous vegetation. This can result in accidental removal of sensitive species or damage to individuals. This impact is most likely to affect *Machaeranthera coloradoensis, Botrychium paradoxum,* and possibly also *Astragalus leptaleus.* This could result in direct effects or loss of individuals. *Machaeranthera coloradoensis* will over time re-colonize old road banks, but the *Botrychium* species probably wouldn't. Depending on the time of year that treatments are conducted, negative direct impacts to undetected *Botrychium paradoxum* and *Machaeranthera coloradoensis* individuals could also include trampling or crushing of above-ground vegetative and reproductive parts (summer to fall), or crushing the underground portions of the plant (year round) by road construction, reconstruction, or traffic. As *Botrychium* spend the first phase of their life completely underground, undetected individuals could be adversely directly impacted by crushing due to compaction of the soil. This impact would be reduced if treatments near known or unknown populations were over snow, although there probably would be some impacts even in that case.

Sensitive plant species could incur direct impact if broadcast burning were to consume an individual or population. Pile burning could directly impact *Machaeranthera coloradoensis or Botrychium. paradoxum* by consuming individuals and killing underground portions of the plant, if the piles were constructed over individuals or populations. There is also the potential that staging areas could occur on populations of these species. This could result in injury or mortality for individuals or populations.

Astragalus leptaleus, Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, and *Utricularia minor* could be directly affected by foot traffic trampling individuals. This could result in injury or mortality of individuals, but light foot travel[9] is not anticipated to have more than a localized impact; heavier foot travel or travel by motorized or mechanical equipment would cause significant impacts through alteration of the water table. Most of these species grow in habitats that often have standing water or high water tables. Legal and regulatory limitations on soil-disturbing activity in these areas reduce the potential for direct impacts.

Indirect effects common to most actions

Many of the activities included in the action alternatives will result in some level of soil disturbance, ranging from negligible disturbance from walking to substantial soil disturbance caused by road construction or mechanical timber harvest equipment. However, in accordance with required soil standards soil displacement and adverse compaction will not exceed 15% of a harvest unit. The creation of bare soil from soil disturbance could result in invasion by nonnative plants or weeds or growth of pre-existing infestations, which could adversely impact all sensitive species if they were to occur near the disturbances where invasive plants occur (discussed below). The changes in microclimatic conditions where there is bare or disturbed soil could impact *Botrychium paradoxum* from the drying of the soil, which would result in desiccation or disruption of mycorrhizal networks and deterioration of plant health. Conversely, for disturbance niche species, some benefit could occur from creation of suitable habitat.

Any amount of bare soil exposed near a fen will result in some erosion and resulting sedimentation into the fen. Sedimentation in fens can affect sensitive species indirectly, by inhibiting peat formation (D. Weixelman, personal communication, 2014) which will ultimately result in reduced suitability of habitat and population decline. Sedimentation could also bury portions or the entirety of individuals.

Dust and other airborne material created by vehicles on roads, soil-moving equipment, mastication equipment, etc. could settle on the leaves of sensitive plant species. This could result in decreased vigor and adversely impact photosynthesis, transpiration and respiration (Farmer 1993). This impact is likely to be short-term and negligible as when the rainy season begins, the dust will be washed off. This is more likely to impact species in the units with multiple entries and those adjacent to roads. If dust abatement compounds are used ($MgCl_2$ or $CaCl_2$), there is the potential for toxicity to sensitive plants growing close to treated roads, resulting in reduced vigor or mortality of individuals or populations; although most studies have shown effects of dust abatement compounds to be less than effects of road dust on untreated roads.

Reduction in tree canopy will be a consequence of many of the proposed treatments, such as timber harvest, mastication, prescribed fire, removal of hazard trees, and hand thinning. The magnitude of the resulting indirect impacts depends on the amount of tree canopy reduction. Target levels of post treatment canopy cover vary depending on pre-treatment stand conditions, affected vegetation type, and prescription objectives. The effect of tree canopy reduction with prescribed fire would not be a uniform reduction across the landscape, but would occur as a mosaic with patches of tree canopy loss, and adjacent areas with no net change. More uniform patterns of tree canopy removal would result from hand and mechanical treatments, though follow up prescribed fires could result in further decreases in tree canopy.

Where whole stands have dead or nearly-dead tree canopies, proposed treatments would not reduce live canopy by much. In this project, treatments in mostly-live spruce stands (“resiliency” treatments) would

[9] Less than two passes on the same trail per day.

all be partial cutting, never affecting whole stands or large portions of them. Treatments in aspen stands would affect a much larger portion of the tree canopy, because that is what results in greatest amount of sprouting, and ensures successful regeneration of the new stand of aspen.

Merriam et al. (2006) found that the greatest factors correlated with nonnative cover and abundance are overstory canopy, litter cover, duff cover and duff depth (all negatively correlated), in a wide variety of vegetation types. Where vegetation is cleared and there is little to no overstory remaining, the risk for invasions by nonnative plant species is high, though generally localized. Reducing overstory canopy allows light to penetrate to the soil surface and this, combined with reduced water and nutrient competition from the shrub layer, can allow for invasive nonnatives to increase in distribution and abundance. The removal of overstory or understory can result in increased solar radiation, which changes evapotranspiration rates and changes microclimate in the understory. This has the potential to create suitable habitat or eliminate suitable habitat, depending on the species of concern. The removal of vegetation can also open areas to access by recreating public, livestock, or big game. This can result in adverse indirect impacts to sensitive species by the recreationists or animals introducing or spreading invasive plants or trampling sensitive plant individuals or habitat.

Indirect impacts caused by introduction or spread of invasive plant species

Most actions associated with project implementation have the potential to increase invasive nonnative plant species abundance and distribution, which will be referred to in subsequent sections. Species could be newly introduced, or there could be increases in abundance and distribution of invasive plant species that are already found within the project area. However, consistent use of design feature IW-1 thru IW-4 (Appendix B of the Final EIS) will significantly reduce the probability of spread through avoidance of areas having existing populations of invasive plants, proper pre-cleaning of equipment and aggressive treatment when populations are discovered. There is the potential for adverse impacts to sensitive plants species due to invasive plant species.

There are two avenues in which project activities can indirectly impact sensitive plant species by facilitating invasive species:

1. Introduction of new species to the project area, or introducing invasive species to new areas in the project area.
2. Alterations of habitat that result in the increased abundance and distribution of invasive plant species already known to occur within the area.

Invasive species impact native communities and biodiversity of native species in several ways, including changes in plant community structure and changes in native species richness and abundance. The mechanisms responsible for these changes are often poorly understood, due to the complex nature of interactions between species and the various trophic levels in a community (Levine et. al 2003). Some of the mechanisms for changes in communities include changes in the soil chemistry (salt accumulation, changes in nitrogen cycling, allelopathy[10]), changes in site and food quality and quantity for other trophic levels, changes in soil biota, changes in soil moisture, competition for resources such as light and

[10] "a biological phenomenon by which an organism produces one or more [chemicals] that influence the growth, survival, and reproduction of other organisms" (en.wikipedia.org).

nutrients, and changes in ecosystem processes, such as hydrologic regimes or fire regimes. Invasive plant species also impact and alter successional pathways

Pile burning

There is soil disturbance resulting from the burning of piled slash. Burning of slash is usually done in spruce stands, to eliminate habitat for spruce beetle, and sometimes to further reduce fuels. In locations where pile burning occurs, there is the potential for soil to rise to high temperatures due to increased residence time associated with concentrated fuels. The larger the pile being burned, the higher the soil heating temperatures, the deeper the heat pulse and the longer the soil will take to recover to normal temperatures (Massman et. al 2003). Depending on the size of the pile, soil heating, and residence time during burning operations, the soils below may become sterile and native seed banks will be reduced or eliminated, and can reduce soil microbial communities (Jiménez Esquilín and others 2007). Studies have found that the footprint of slash piles that have been burned can be vulnerable to invasive plants (Keeley 2006, Scherer and others 1999) which could adversely impact any sensitive species in the vicinity of burn piles. There could also be adverse impacts to *Botrychium paradoxum* if there were individuals in the underground stages where the piles were burnt, or if mycorrhizal relationships were eliminated due to the intense soil heating.

Prescribed fire

Coppice cutting will be the primary treatment method in aspen stands, in order to maximize sprouting. Sprouting is aspen is regulated by two known factors, production of a hormone in the crowns that suppresses sprouting and warmth of the soil in spring (Hungerford 1988). Fire has a relatively small role in pure aspen stands, and the difficulty of carrying fires in aspen is well known. In mixed aspen-conifer stands, aspen plays a key role in sprouting quickly after fire or other disturbance, with conifers growing up later to replace the aspen canopy.

When the soil is exposed to heat the physical, chemical and biological properties can be altered (Wohlgemuth et al. 2006), and depending on fuel loading there is a range of potential effects. Where fuel loading is high effects could be similar to that for pile burning, though more frequently there will likely be lower intensity fire. With prescribed fire, the vegetation is consumed, nitrogen and phosphorus are often made available which could adversely indirectly impact sensitive plant species and their mycorrhizal symbionts by facilitating invasion of invasive exotic plant species but also beneficially impact sensitive plant species, such as *Botrychium paradoxum,* and their mycorrhizal symbionts in the short-term by freeing nutrients for their use (Johnson-Groh and others 2002). It has been shown that some fen species are colonized by arbuscular mycorrhizal fungi, which show a decrease in mycorrhizal colonization when phosphorus is added (Cornwell and others 2001). If phosphorus is released during fires in the vicinity of a fen, there could be a longer term adverse effect by this decrease in colonization, due to the short term increases in phosphorus availability.

Roads

There are several factors specifically associated with roads (existing, new construction, reconstruction and decommissioning) that have the potential to directly and indirectly impact sensitive plants. Existing roads are corridors that can fragment populations and/or habitat, create dust, spread and/or introduce invasive species. Roads result in localized soil compaction which can alter the hydrology of an area and disrupt mycorrhizal networks.

Roads and their maintenance are areas where there is repeated soil disturbance, both on and adjacent to the road prism. This repeated soil disturbance creates prime suitable habitat for invasive plants to become, and remain established. This is compounded by there also being high concentrations of vectors for invasive species (vehicles, etc.); see discussion on invasive plants above. Road activities are likely the greatest contributor to invasive plant risk for this project (Birdsall and others 2012) [please refer to the Invasive plant risk assessment in the project record for detailed description]. Road maintenance can also remove individual sensitive plants (or all of population if occurs within road). New, or temporary road construction, also results in localized, but intense ground disturbance that leaves the road bed devoid of previous vegetation. This can result in impacts to mycorrhizal symbionts. This impact is most likely to affect *Botrychium paradoxum.* This could result in in interruptions to the mycorrhizal networks, reducing the health and vigor of populations.

Road use and construction can alter hydrologic function. Roads can result in water diverting into a different course. Roads contribute to heightened sedimentation levels (Gucinski and others 2001) which if occurring upslope from a fen could result in sediment accumulating in the fen. As mentioned above, sediment in fen could smother sensitive plant species or result in retarding peat accumulation rates, diminishing suitable or occupied habitat health and suitability.

Roads can result in increased access to areas that were previously inaccessible, or rarely accessed by recreationists. If new road construction or temporary road construction resulted in increased access to areas that had sensitive plant populations, including fens, it could result in trampling of individuals, introduction of invasive species, and use of motorized vehicles in sensitive fens or wetlands, altering their hydrology or trampling sensitive species.

Mechanical treatments

Mechanical treatments will usually occur on slopes less than 40%, because of inherent limitations to the equipment usually used. Mechanical treatments in the wildland-urban interface could be on steeper slopes if access is available from an existing road. Mechanical treatments include hazard tree removal and will differ between spruce-fir and aspen vegetation types. The sensitive species occur in other types or microsites embedded within spruce-fir, aspen, or a mix of these. Direct effects of mechanical treatments would be limited to sensitive species that may be found in spruce-fir or aspen stands, notably *Botrychium paradoxum*.

There are potential indirect effects, as described below, and potential effects from associated actions such as road building, burn piles, staging areas, and other activities, that are described in the respective sections in this part of the effects analysis.

All actions associate with mechanical treatments have the potential to introduce invasive species, or to increase the extent of existing infestations of invasive species. This would have adverse effects on sensitive plant species.

In aspen, the prescription is primarily for coppice cutting, which is a form of clearcutting. No sensitive species are known to occur in pure aspen stands, but may occur in areas that are adjacent to stands of aspen, or in mixed aspen-spruce-fir. However, most aspen stands, whether pure aspen or mixed with conifers, have abundant leaf litter from aspen itself and the many shrubs, grasses, and forbs associated with aspen. Most aspen clearcuts produce little bare soil on which weeds could invade, and what bare soil that is created is quickly covered with aspen sprouts and other vegetation. Design criteria should still reduce soil disturbance to the minimum possible while completing the activity, as it would be a general rule in all vegetation types.

In spruce-fir vegetation types prescriptions would vary, ranging from group selection treatments (small patch cuts) to uneven age harvesting (selected individuals cut). There is the potential for the promotion of invasive plant populations due to reduced canopy cover, soil compaction altering hydrologic regimes, or soil disturbance resulting in exposed soil that could erode downhill. .

Heavy machinery can substantially disturb the soil, especially tracked machinery typically used to construct or rebuild roads. "Although other forest management activities usually occur on a larger proportion of the landscape, the erosion rates on roads are the dominant source of sediment in most managed forests" (Robichaud and others 2010). Soil disturbance can result in creation of suitable habitat for invasive plants, increases in erosion, alteration of the microtopography of the soil changing the pathway of water, and disruption of mycorrhizal networks. Heavy machinery can also result in soil compaction which could alter surface and subsurface hydrologic flow or disrupt mycorrhizal network. If a fen occurred in the same small watershed as extensive soil disturbance, surface erosion or disruption of groundwater could occur, resulting in impairment of functions of the fen.

A study conducted in the Colorado Front Range found that when chipping treatments were conducted, if a layer of woodchip was left in place, there was a reduction in understory growth (Wolk and Rocca 2009). Another study in the Front Range found no erosion in stands where chipping residue had been left (reported in Robichaud and others 2010). This effect would be beneficial if the woodchip reduced the potential for invasive plant establishment, but adverse if it smothered sensitive plant populations.

If timber harvest treatments result in high levels of aspen regeneration (possible in both aspen and spruce-fir-aspen mix) there is the potential for increased browsing from native ungulates and domestic grazers, which could cause more soil exposed and increase the likelihood of invasive plants.

Replanting and preparatory activities for replanting may occur in spruce-fir, especially where the stand is mostly dead from spruce beetles or other factors. Preparing the sites for replanting can involve soil disturbance, especially if scarification of the soil is used. This could result in disruption to mycorrhizal symbionts for *Botrychium paradoxum.* There is also the potential for introduction of invasive plants.

Staging areas and landings

Staging areas and landings will be used for parking and preparing heavy equipment, parking vehicles, piling logs for hauling, etc. There will likely be high levels of soil disturbance and potentially compaction. With the high levels of traffic in these sites they are vulnerable to invasive plant introduction and proliferation. This has greatest potential for adverse indirect impacts to sensitive species.

Cumulative Effects

"Cumulative effects are those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action" (50 CFR 402.02). The cumulative effects described below are common to all action alternatives.

Activities on private and state lands

There will be continued livestock grazing and pasturage on private and state lands. Also, thinning activities used to create defensible space and fuel breaks around private property will continue.

Recreational activities

There has been a strong trend for several decades towards more recreation on National Forests. We can expect more pressure on roads and trails, and more and more demand for off-road vehicle use. The vehicles will continue to get larger and more powerful. More weed species will become introduced, and existing infestations will get larger.

Road maintenance by state and county

County road maintenance was identified as a potential cumulative effect for *Machaeranthera coloradensis* and *Botrychium paradoxum*. There are known populations of *Machaeranthera coloradensis* occurring along county maintained roads. County road maintenance could result in additional impacts to individuals such as crushing, or removal from road maintenance equipment. This would act synergistically with the proposed action to add to the potential for decreased vigor and mortality of individuals, and could extirpate any of the populations as they are dispersed both along the road where impacts could occur, and adjacent to the road.

Climate change

Climate change is already noticeable in changing patterns of precipitation, earlier springs, warmer temperatures, and less precipitation in the form of snow. Current trends indicate periods of more severe drought and more extreme weather events could add stress to Forest Service Sensitive species populations. Within the next century, average temperatures are projected to increase and precipitation is projected to decrease in some of the interior areas of North America (Watson et al. 2001), which will affect plant community composition. *Machaeranthera coloradensis* apparently has the ability to tolerate somewhat stressful environments, exist at a range of elevations, and grow in a variety of habitats, which may help the species persist (Beatty et al. 2004), although it could be affected where it grows at relatively low (non-alpine) elevations. Many of the sensitive fen and wetland species are Pleistocene relicts disjunct from cooler habitats already at the edge of their range, so if they were present climate change would likely add stress to them.

Design features

Design features are an integral part of the effects determination. Design feature were developed in response to the for mention foreseeable adverse impacts to sensitive species (Table 17). Design feature development and emphasis was placed on reducing, if not eliminating impacts that were likely to lead to losses in viability. Effects analysis assumes design features will be implemented and it is the residual effects that get analyzed in the effect determination.

Table 17. Design Feature for sensitive species for all SBEADMR project alternatives. (Appendix B of the Final EIS).

Species of Concern	Design Criteria Function in reducing effects	Design Feature	Identifier Appendix B of the Final EIS
Upland (non-wetland) Sensitive Species	Prevent take of individuals or populations that would lead to a loss in viability	Sensitive plant populations will be flagged and avoided for all ground disturbing activities with a buffer of 20 – 100 feet (as determined during project analysis).	FSSP-10
		Proposed road construction, reconstruction, landings and staging areas in potential habitat for sensitive species will be designed and marked on the ground only after the areas have been surveyed by a qualified botanist in the proper season.	FSSP-10
All Sensitive Species	Prevent toxicity to individuals or populations that would contribute to a loss in viability.	During prescribed fire operations (including aerial or ground broadcast burning), ignitions and other fuel treatment activities would be located away from sensitive plant species populations and wetlands.	FSSP-2B
		Dust abatement (use of $MgCl_2$ or $CaCl_2$) will avoid sensitive species populations and wetlands by 500 feet.	FSSP-2C
		Avoid sensitive species populations and wetlands with chemical weed treatments.	FSSP-2D
	Allow for adequate planning time to analyze and develop site specific recommendations and appropriate protection measures.	Pre project implementation assessment will be conducted by a qualified botanist. Notification will be given with sufficient time for field surveys during the proper season to be conducted for sensitive plant species expected to occur in the project area or affected by it.	FSSP-2A
		Any Region 2 sensitive plant species new to list or located after contract or permit issuance will be appropriately managed by active coordination between permittee, contractor or purchaser, Forest Service line officer, project administrator, and botanist.	FSSP-2E
Machaeranthera coloradoensis, Botrychium paradoxum	Prevent take of individuals or populations that would lead to a loss in viability.	Minimize use of roads passing through known sensitive species sites.	FSSP-3A
		Proposed road construction, reconstruction, landings and staging areas in potential habitat for sensitive species will be designed and marked on the ground only after the areas have been surveyed by a qualified botanist in the proper season.	FSSP-10
		If there is tree canopy covering occupied habitat, maintain pre-project tree canopy over habitat.	FSSP-4B
		During treatment, temporary roads will be signed and effectively closed to the public if near a wetland.	FSSP-5A
Fen sensitive species: *Carex diandra, Drosera rotundifolia, Eriophorum, chamissonis, E. gracile, Salix candida, Sphagnum angustifolium, Utricularia minor*	Reduce potential for recreation-related resource damage to fens.	Keep roads and trails out of wetlands and their water influence zones (WIZ).[14]	FSSP-6A
	Maintain fen hydrologic function [soil compaction, water diversion, dewatering] that would reduce	Restore existing disturbed areas that are eroding and contributing sediment to the wetland.	FSSP-6B
		Delineate Water Influence Zone (WIZ) prior to project implementation according to Regional and National Standards.[15]	WQSP-2A
		No mechanized equipment operation will occur in the water influence zone (WIZ) of a wetland.	FSSP-7A/B

[14] USDA Forest Service 2006.

[15] USDA Forest Service 2006, 2012.

Species of Concern	Design Criteria Function in reducing effects	Design Feature	Identifier Appendix B of the Final EIS
	suitability/sustainability of rare fen habitat.	No treatment activities or vehicle use in wetlands or their water influence zones.	FSSP-7A/B
	Prevent take of individuals or populations that would lead to a loss in viability.	Prevent mineral sediment deposition from occurring in wetlands.[3]	FSSP-7C
		Develop an erosion and sediment control plan to avoid or minimize downstream impacts using measures appropriate to the site and the proposed activity.[16]	FSSP-8A
	Prevent sedimentation events that would reduce or impair wetland functions.	Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area.	WQSP-5A
		Limit roads and other disturbed sites to the minimum feasible number, width, and total length. Minimize sediment discharge into streams, lakes, & wetlands during construction and stabilize & maintain disturbed sites to control erosion.	FSSP-8C
		Maintain sufficient upslope ground cover to prevent sediment movement downward into wetland.	FSSP-8D
		Reclaim roads, landings and other disturbed sites when use ends.	Water quality and soil production objective 8
		Avoid treatment activities and equipment use in wet or moist meadows.	FSSP-9A
Astragalus leptaleus	Maintain functions of riparian wet or moist meadows.	Design stream crossings at armored points, or armor them to prevent loss of functions in wet or moist meadows.	FSSP-9B
	Prevent sedimentation events that would reduce or impair wetland functions.	Avoid treatment activities and equipment use in wet or moist meadows.	FSSP-9A

[16] USDA Forest Service 2012, Austin 2008.

COMPARISON OF ALTERNATIVES

Table 18 displays in tabular format the main differences in the alternative in reference to factors that could affect sensitive species. The key distinguishing factor is where the treatments occur and whether there are sensitive plant populations and what activity type is utilized for implementation. The following table attempts to capture the differences.

Table 18. Comparison of overlapping habitat for sensitive species by Alternative

Comparative descriptor	Alternative 1	Alternative 2	Alternative 3
Priority Treatment Areas	No Actions.	Approximately 4,437 acres of Priority Treatment Areas overlap aquatic habitat features (fen, riparian, wetland, waterbody)	Approximately 2,937 acres of Priority Treatment Areas overlap aquatic habitat features (fen, riparian, wetland, waterbody)
Hazard Tree Treatment	No Actions.	Approximately 17,388 acres will be treated. Of those acres, 570 overlap aquatic habitat features (fen, riparian, wetland, waterbody)	Approximately 24,693 acres will be treated. Of those acres, 634 overlap aquatic habitat features (fen, riparian, wetland, waterbody).
New Roads (outside PTA's)	No Actions.	There will be approximately 213 acres of new roads outside PTA's (does not include reconstructed or decommissioned roads). Of those acres, 5 overlap aquatic habitat features for this activity.	There will be approximately 169 acres of new roads outside PTA's (does not include reconstructed or decommissioned roads). Of those acres, 4 overlap aquatic habitat features for this activity.
Invasive species	No actions.	Moderate use of mechanical treatment, moderate risk for introduction or spread of invasive plants. Potential for introduction and spread of invasive plants due to increased vectors over a larger area.	Area of treatment with highest concentrations of invasive plants, local introductions the greatest risk. Higher risk of introduction with higher road maintenance. Would occur primarily in areas that already have the highest infestations, making it more likely invasive plants would be spread.
Environmental Baseline	No actions.	Largest footprint for PTA's. With the exception of invasive plant introduction, could have fewest impacts due to dispersed application of treatments.	Footprint of PTA"s would occur in areas that have generally experienced the greatest ongoing habitat alterations (development) and would have the smallest change from environmental baseline to post implementation environment.
Fen Wetlands Riparian Waterbodies (aquatic habitat features)	No actions.	Has more potential to include aquatic habitat features. There is approximately 5,012 acres of aquatic habitat features within potential affected area (Johnston and others 2012)	Would include the fewest number of aquatic habitat features, and hence would likely adversely impact the sensitive species known from fens the least. There is approximately 3,575 acres of aquatic habitat features within potential affected areas. (Johnston and others 2012)

Alternative 2 (Agency Preferred Action)

Overall, Alternative 2 overlaps the largest amount of acres of suitable habitat for sensitive species. The actual impacts and effects to sensitive species will depend on where the treatments occur. The potential for impacts could be dispersed due to the larger ratio of treatment per area, resulting in potentially less direct and indirect effects. This alternative also offers the greatest number of acres to choose treatments in that could have the least amount of impacts to sensitive species. Conversely, there is also the potential for greater effects from invasive plant spread (hence impacts from invasive plants), as this alternative has the potential to treat across a large landscape, which could result in invasive species being introduced into the greatest amount of uninfested areas. Project Design Features and the ***Pre-Treatment*** Checklist would be followed in order to assure implementation of projects stay in compliance with and consistent with the Forest Plan (Appendix B of the Final EIS).

The residual effects from this alternative are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

Sensitive Species within Alternative 2 Area

One of the ten sensitive species (*Botrychium paradoxum*), has potential to be present or its habitat within lightly disturbed microsites (old roads and road cuts) within or close to mesic coniferous stands above 10,500 ft. in elevation (to be conservative, areas > 8,500 ft. in elevation is spatially displayed on map below). Potential habitat for *B. paradoxum* could be found within aspen, spruce-fir, lodgepole and cool-moist mixed conifer cover types in alpine and subalpine zones. 90% of the potential affected area for Alternative 2 occurs above 8,500 ft. in elevation. Of that, 65 % occurs on west, northwest, north, northeast, and east facing slopes and tends to be more mesic. Figure 33 identifies new roads outside PTA's (does not include decommissioned or reconstructed) above 8,500 ft. and potential affected areas above 8,500 ft. that have a west, northwest, north, northeast, or east facing slope. There are no hazard tree treatments that occur at this elevation (and above) with these aspects (west, northwest, north, northeast, and east). Existing roads (new, decommissioned or reconstructed) are also identified inside and outside of PTA's for all elevations (does not include haul roads). Field surveys for *Botrychium paradoxum* should focus on these habitat areas but not limited to (Figure 33), as most often *Botryichium* species occur in microsites that may occur within these habitat areas. These microsites can be difficult if not impossible to identify with GIS data. Appropriate design features would be applied to protect suitable habitat for sensitive species based on best available science if found within treatment areas.

Another sensitive species, *Macahaeranthera coloradensis*, is most likely found in microsites within the proposed Alternative 2 project area. This species inhabits mountain parks, slopes, rock outcrops and dry tundra at elevations ranging from 8,500 – 12,500 ft. *Macahaeranthera coloradensis* prefers exposed substrates of calcareous, sedimentary and volcanic origin, and it may rely on periodic natural disturbances to maintain its open habitat. These habitat locations are too difficult to identify with GIS data.

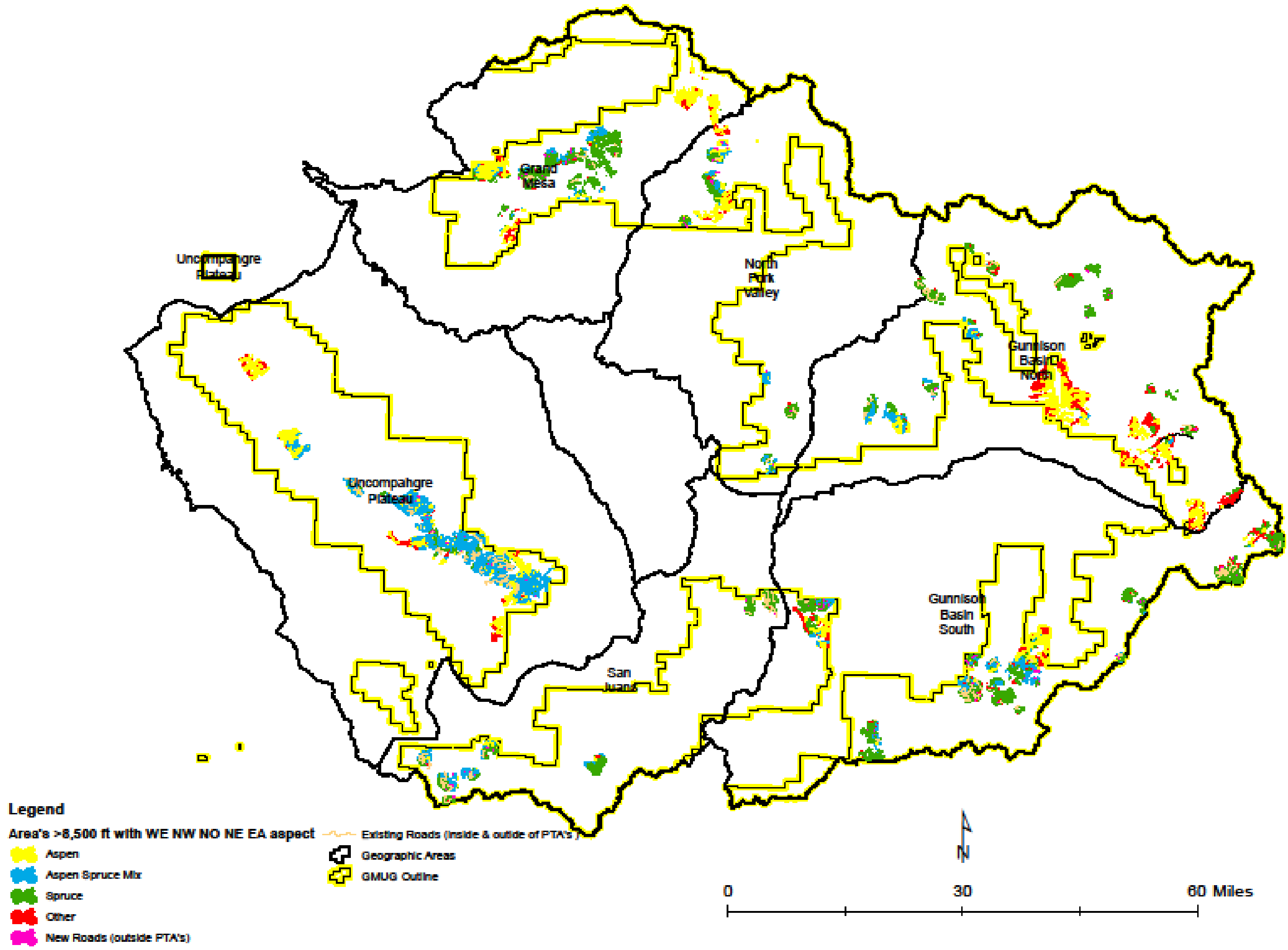


Figure 33. Species Cover and new roads outside PTA's (does not include decommissioned or reconstructed) above 8,500 ft. in elevation that occur on WE,NW,NO,NE,and EA aspects. Existing roads (new, decommissioned or reconstructed) include all elevations inside and outside of PTA's (does not include haul roads).

The total acres within the potential affected area of Alternative 2 that overlap fen, wetland, riparian, or waterbodies is 5,012 (<1% of the total potential affected areas). Of those acres, 1% have a fen component, wetland 1%, riparian 95%, and waterbodies 3%. There are 4,437 acres of aquatic habitat features overlap Potential Treatment Areas of which 72% occurs within non-commercial burn and mechanical treatment locations (Table 19). Prior to implementation, field surveys would verify presence or not of any threatened or sensitive plant species occurrences or where suitable habitat may be present in project areas. See Figure 34 for the extent of aquatic habitat features within the proposed action's maximum footprint. Appropriate design features would be applied to protect any threatened or sensitive species or suitable habitat found within treatment areas based on best available science (Appendix B of the Final EIS).

Seven of the ten sensitive species (*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor*), have the potential to be present or their habitat within wetland/fen areas. One of the ten sensitive species (*Astragalus leptaleus*) is most likely to occur in moist swales and riparian meadows. Most of these areas occur within riparian areas. The above species grow in habitats that are often wet and have standing water or high water tables. These habitat types are sensitive to ground disturbing activities and can be negatively impacted from activities occurring above, adjacent to, or within. Legal and regulatory limitations on soil disturbing activity in these areas will reduce the potential for direct impacts. In the Forest Service, wetlands are surrounded by a buffer called the *water influence zone* (USDA Forest Service 2006). Since these laws and regulations severely restrict any activities in wetlands and limit activities in the water influence zone around them, activities implementing this project will avoid wetlands. Design criteria have been written for this project that avoids activities in wetlands (WQSP-2A, Appendix B of the Final EIS).

Field survey should not be limited to the aquatic habitat features spatially identified on map below, but rather areas to consider when conducting field surveys (Figure 34). Appropriate design features would be applied to protect any threatened or sensitive species or suitable habitat found within project area based on best available science (Appendix B of the Final EIS).

Table 19. "Areas within the proposed action where design features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be applied" (Appendix B of the Final EIS).

		Potential Affected Areas							
		Priority Treatment Areas							
		Commercial Treatment			**Non-commercial Treatment**				
Geographic Area	**Category**	**Resiliency**	**Salvage**	**Combination Resiliency/Salvage**	**Burn and Mechanical**	**Mechanical Only**	**Hazard Trees (Resiliency/Salvage)**	**New Roads Outside PTA's**	**Total**
Grand Mesa	Fen	2		10	0	0	2	0	**13**
	Riparian	114	0	88	538	45	49	1	**834**
	Water	17	0	22	19	1	2	0	**61**
	Wetland	1	0	1	11	0	0	0	**14**
Gunnison Basin North	Fen	0		0	0	0	0	0	**0**
	Riparian	176	22	89	1232	0	172	2	**1693**
	Water	3		0	15	0	0	0	**18**
	Wetland	0		0	20	0	1	0	**20**
Gunnison Basin South	Fen	0	0	0	0	0	0	0	**1**
	Ripaian	45	26	41	482	0	133	1	**727**
	Water	0	1	0	3	0	0	0	**4**
	Wetland	2	1	1	11	0	1	0	**15**
North Fork Valley	Riparian	126	3	38	276	10	107	1	**560**
	Water	8	0	3	8	0	1	0	**20**
	Wetland	2	0	0	0	0	0	0	**2**
San Juans	Fen	8	0	3	0	0	0	1	**12**
	Riparian	17	4	45	2	0	34	0	**102**
	Water	0	0	1	0	0	0	0	**1**
	Wetland	6	0	6	0	0	0	0	**13**
Uncompahgre Plateau	Fen	0	0	0	0	0	1	0	**1**
	Riparian	150	2	119	513	0	62	0	**846**
	Water	5	0	2	34	0	5	0	**47**
	Wetland	0	0	0	10	0	0	0	**10**
	Grand Total	**681**	**59**	**469**	**3173**	**55**	**570**	**5**	**5012**

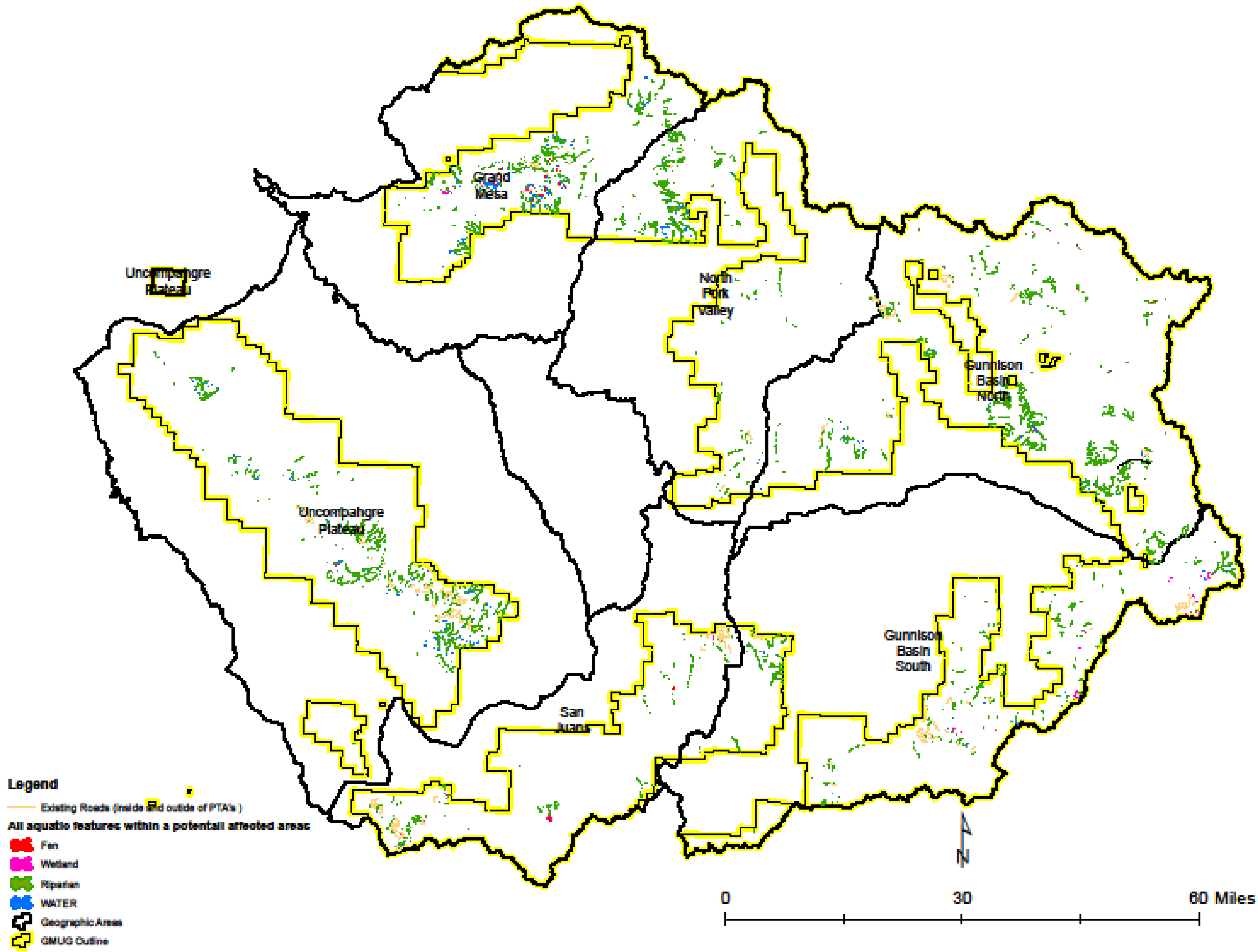


Figure 34. All fen, wetland, riparian, and waterbodies (aquatic habitat features) that occur within the proposed action areas (Johnston and others 2012).

Hazard Tree Treatments

There will be 570 acres of hazard tree treatment within aquatic habitat features (11%). Design feature have been established to minimize the impacts and hence decrease the residual effects of project associated activities within and adjacent to riparian habitat (Appendix B of the Final EIS). The ideal buffer around fens and their associated wetlands is 100 feet minimum from the outer edge of the wetland complex which defines the ideal water influence zone (WIZ) and no harvest or mechanical travel should occur within 100 ft. of that WIZ (WQSP-2A, Appendix B of the Final EIS). Wetlands ≥ ¼ acres ideal buffer is 100 ft. from edge and restricted activity is 50 ft. from WIZ and for seeps/springs/wetlands ≤ ¼ acres ideal buffer should be 50 ft. from source or edge with restricted activity 25 ft. from WIZ (WQSP-2A, Appendix B of the Final EIS). Riparian systems vary depending on if the system is perennial, intermittent or ephemeral. Perennial systems buffer is 100 feet from stream bank with restricted activities 50 ft. from WIZ, 50 ft. from intermittent stream and ponds bank or high water mark with restricted activity 25 ft., and ephemeral streams and swales is 25 ft. from edge (WQSP-2A, Appendix B of the Final EIS).

Design features were developed in response to the foreseeable adverse impacts to sensitive species (Table 17, Appendix B of the Final EIS). Design feature development and emphasis was placed on reducing, if not eliminating impacts that were likely to lead to losses in viability. The residual effects from this treatment are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

New Road Construction

There will be more acres of new roads constructed outside PTA's (does not include decommissioned or reconstructed) in Alternative 2 (213 acres) in comparison to alternative 3 (169 acres). Within the 20 ft. buffered areas on either side of new road (outside PTA's), there is approximately 5 acres of aquatic habitat features that spatially overlap areas proposed for new road construction. For new roads inside the PTA's, aquatic habitat features were lumped into treatment areas.

For the purpose of this section, I will consider all new roads (new, decommissioned, and reconstructed inside and outside of PTAs, buffered on either side by 20 ft.). All roads combined (excluding haul roads) encompass approximately 1,425 acres (Figure 35), twice the amount of acres for roads occurring within this alternative than for alternative 3 (666 acres). Road activities are likely the greatest contributor to invasive plant risk for this project (Birdsall and others 2012) [please refer to the Invasive plant risk assessment in the project record for detailed description]. New road construction also results in localized, but intense ground disturbance. Road use and construction can alter hydrologic function. Roads can result in water diverting into a different course. Roads contribute to heightened sedimentation levels (Gucinski and others 2001), which, if occurring upslope from a fen, could result in sediment accumulating in the fen. The 1,425 acres of proposed new, decommissioned, and reconstructed roads is the maximum impact scenario. Not all new roads will be constructed at the same time but rather over the life of the project (10 - 12 years). New roads (inside and outside of the PTA's) will only be used by the purchaser and for administration use only (no public use at any time). Approximately 70% of the new roads will be closed immediately after completion of the sale, and all constructed roads will be decommissioned within 5-years of sale closure. Existing roads that are re-aligned due to resource concern will be retained as part of the Forest Transportation system following decommissioning of the old route.

Design features have been established to minimize overall impacts and decrease the effects of treatment-associated activities within and adjacent to riparian habitat (Table 17, Appendix B of the Final EIS). Design feature development and emphasis was placed on reducing, if not eliminating impacts that were likely to lead to losses in viability. The residual effects from this activity are within the range of alternatives described in the ***direct***, ***indirect***, and ***cumulative*** effects under effects common to all alternatives.

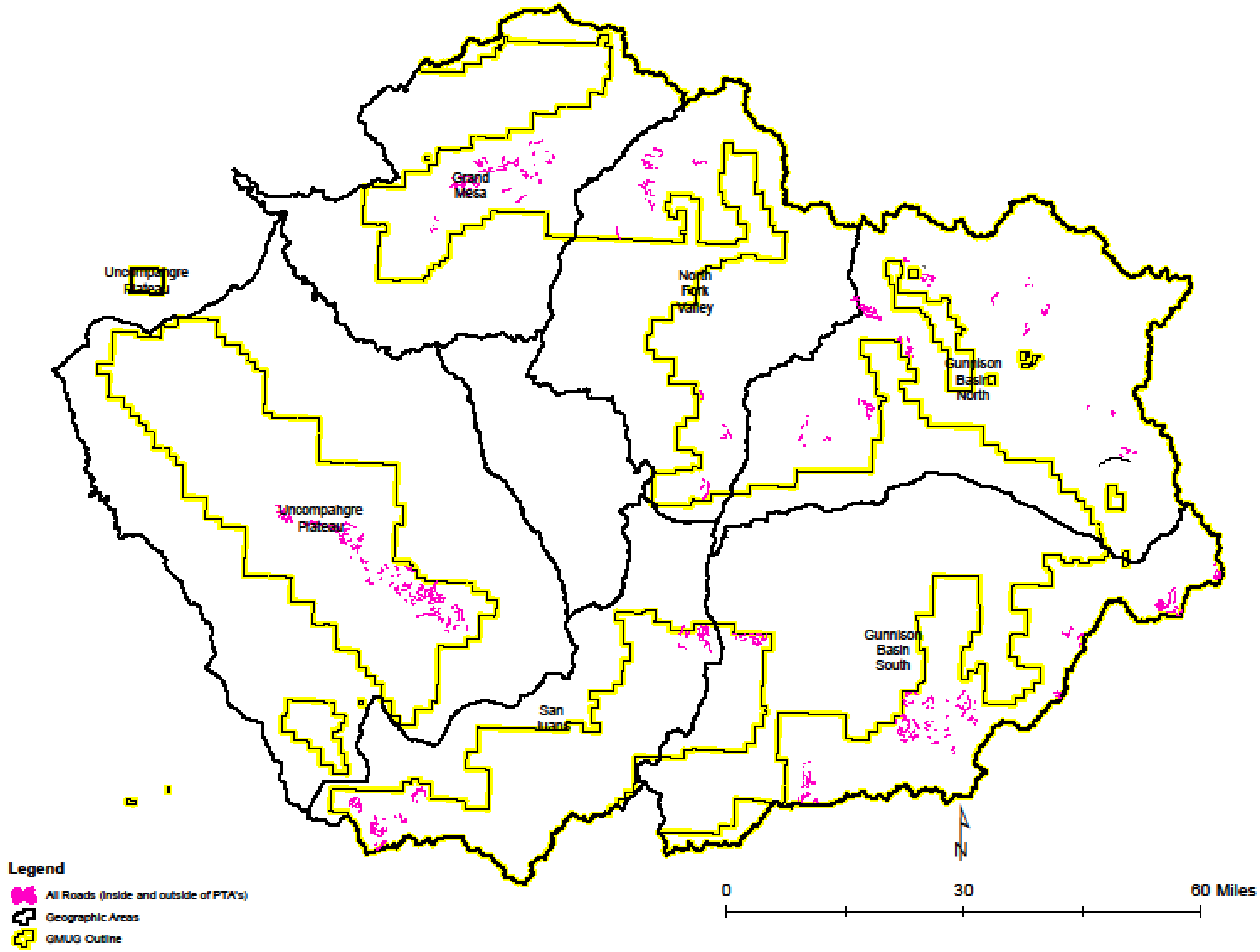


Figure 35. All new roads (new, decommissioned, and reconstructed) buffered 20 ft. on either side, inside and outside Priority Treatment Area (haul roads excluded).

Effects to Sensitive Species

The following is a description of the more likely residual effects per species, considering appropriate application of design features (Table 17, Appendix B of the Final EIS). Surveys would be conducted during treatment layout to assess presence or absence (FSSP-2A, Appendix B of the Final EIS).

Astragalus leptaleus

Direct Impacts. Potential for direct impacts to *Astragalus leptaleus* from ground-disturbing activities include direct injury, or mortality of individuals. This would occur if the population was growing in a "subriparian swale" or other mesic site not identified for protections based on design features protecting wetlands and meadows. But under all action alternatives, surveys would detect populations prior to project implementation and flag and avoidance measures would be followed to protect individuals and populations. This species is rhizomatous which could allow for reestablishment to pre-disturbance levels if only individuals were damaged.

Indirect Impacts. *Astragalus leptaleus* could be adversely indirectly impacted by any action that resulted in changes to hydrology or sedimentation from above, affecting the suitability of its microsite conditions. *Astragalus leptaleus* could also be adversely indirectly impacted by the introduction and spread of invasive species resulting in increased competition, and other effects described in the indirect impacts caused by introduction and/or spread of invasive plant species. *Astragalus leptaleus* could also be adversely indirectly impacted if browsing were to increase due to increases in aspen sprouting in the vicinity of a population. All these indirect effects could result in reduced vigor of the population, reduced habitat for the species and the potential mortality of individuals.

Cumulative Impacts. The cumulative impacts most likely to contribute to impacts for *Astragalus leptaleus* is increased recreational use of the national forests, especially increased off-road vehicle use. Other factors include ongoing grazing on and off federal lands and invasive species. This species is known from habitats (lower elevation riparian) where these impacts occur. The effects from the SBEADMR project are not likely to affect much of the known range and suitable habitat for this species, but there may be long-term adverse impacts that could act synergistically with the cumulative effects resulting in some decline for this species.

Botrychium paradoxum

Direct Impacts. *Botrychium paradoxum,* as described in species accounts and in the environmental baseline, can remain dormant underground for many years, and it has even been shown that the below-ground to above-ground ratio can be very high (Johnson-Groh and others 2002). This would make individuals undetectable during field surveys and so design features would not be implemented for protection of those sites. This could result in some individuals or populations being burned under piles, removed and killed during road construction or desiccated during overstory removal, resulting in the loss of either individuals or entire populations. These same impacts could also result in decreases in individual or population vigor, though it has been observed that the above ground portions are fairly resilient to light disturbance.

Indirect Impacts. The greatest adverse indirect impact to Botrychium *paradoxum* would be impacts to the mycorrhizal symbiont. This has been discussed extensively under the indirect impacts section above, but to summarize, the greatest impacts to mycorrhizal are likely to occur with actions that intensely affect soil and microbial structure and communities. These actions include burn piles, road construction, use of heavy machinery, and skid trails. Another factor of concern is removal of protective canopy for these individuals (sometimes only 20-30 cm tall) by timber harvest or revegetation activities. The magnitudes of impacts to Botrychium paradoxum depend on the magnitude of the impacts to the mycorrhizal symbiont. There are design criteria that prevent more than 15% of the soil from being severely burned, compacted, eroded and displaced. This would likely reduce the severity of impact, though may not fully mitigate all potential negative effects and therefore some reduced vigor in individuals or populations. *Botrychium paradoxum* could also be adversely indirectly impacted by the introduction and spread of invasive species resulting in increased competition, and other effects described in the indirect impacts caused by introduction and/or spread of invasive plant species. *Botrychium paradoxum* could also experience indirect effects from toxicity, especially if they are in the gametophytic underground phase, and dust abatement or herbicides were applied directly or in the near vicinity. This could result in reduced vigor or mortality in some individuals or populations. Indirect effects could arise from changes in canopy cover of associated vegetation due to removal of overstory trees. A decrease in canopy cover may temporarily create habitat for, peculiar moonwort and Colorado tansy-aster by increasing sunlight. Creation of temporary habitat could be beneficial to individuals, but transient habitat seems marginally beneficial on a population level.

Cumulative Impacts. There is only one population of *Botrychium paradoxum* known from the planning area. *Botrychium paradoxum* is thought to be sensitive to extirpation through this part of its range (Farrar and Popovich 2012). This influences the sensitivity of this species to any and all impacts to populations in the planning area to a loss of viability. There are no known threats to the known populations at this time, but one population of *Botrychium paradoxum* is known from a ski resort which could be impacted by ski slope management or recreational use.

Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, and Utricularia minor

Direct Impacts. Design features for this project protect these species from direct effects, all known to occur in fens and occasionally other wetlands, unless personnel were to walk out into a fen or wetland and crush an individual (Appendix B of the Final EIS).

Indirect Impacts. Indirect impacts to *Carex diandra*, *Drosera rotundifolia*, *Eriophorum chamissonis, Eriophorum gracile, Salix candida*, *Sphagnum angustifolium* and *Utricularia minor* would result from impacts to their habitat. As discussed in indirect effects the primary impacts would include sedimentation and alterations to hydrology of the fens or wetlands. Design features have been included to limit the effects of these impacts, but there is still the potential that to some degree that fens could still experience some sedimentation and alteration of hydrology. These effects may be minor, short term influences to fen function, but could result in long term effects that alter to some extent the vigor of these species populations.

Cumulative Impacts. These fen and wetland species may be affected by climate change, especially warming of their fen and wetland habitats and less consistent patterns of precipitation. These species have specific hydrologic habitat requirements, could be indirectly impacted by changes to hydrological processes resulting from roadwork done by the county. This was not found to be a substantial impact in the GMUG fen inventory and assessment (Johnston and others 2012), but in the cumulative effects analysis area there are 2,591 acres of potential fens in the vicinity of roads so there is the potential for road use, improvement and maintenance contributing synergistically to cumulative impacts to the hydrologic function of fens. Many of these species are thought to be Pleistocene relicts disjunct from cooler habitats already at the edge of their range, so climate change may be a substantial effect that is influencing the viability of these species.

Machaeranthera coloradoensis

Direct Impacts. There could be direct effects to *Machaeranthera coloradoensis* from road reconstruction and hauling. Road reconstruction could include widening the road prism, vegetation clearing, installing drainage structures and suitable water crossings, and applying road surfacing. Scraping and reconstructing these roads would directly impact Colorado tansy-aster plants growing in road beds. Individual plants could also be adversely impacted by being repeatedly driven on or parked on. The result would likely be loss of the plants growing in road beds subject to improvement, and a few plants would have reduced vigor or mortality in parking areas. There is also the potential for mortality caused by piles being constructed and burned on a population

Indirect Impacts. Road activities could result in indirect impacts to *Machaeranthera coloradoensis* from dust, dust abatement, and invasive plant spread. Dust could reduce the photosynthetic capacity of individuals or parts of populations. Dust abatement could result in mortality of individuals, though a design feature that limits application of the harmful dust abatement compounds within 500’ of known populations greatly reduce the potential for this impact. Invasive species may spread due to project related activities resulting in increased competition, and other effects discussed above. This indirect impact is not anticipated to be great with project implementation.

Cumulative Impacts. County road maintenance was identified as a potential cumulative effect for Colorado tansy aster. County road maintenance could result in additional impacts to individuals such as crushing, or removal from road maintenance equipment. This would act synergistically with the proposed action to add to the potential for decreased vigor and mortality of individuals, but is not anticipated to extirpate any of the populations as they are dispersed both along the road where impacts could occur, and adjacent to the road where no impacts are anticipated. Livestock grazing is another ongoing activity in Colorado tansy-aster habitat. The effects of grazing on Colorado tansy-aster are probably minimal because it is apparently unpalatable to livestock and prefers habitats that are sparsely vegetated and rocky, which are not preferred for grazing (Beatty et al. 2004)

Alternative 3 (WUI Alternative)

All activities within Alternative 3 are also included in alternative 2. This alternative has the potential for the greatest concentration of effects as it has the highest potential for treatment per area ratio. This would mean higher concentrations of temporary roads, road reconstruction activities, mechanical treatments, and other ground disturbing activities. This could result in the greatest magnitude of impacts associated with the proposed action, though the actual effects could be lower than with the other action alternatives as there is the least amount of suitable habitat for all species considered in this alternative.

Alternative 3 has the greatest overlap and potential treatment intensity with known invasive plant populations and with already altered baseline habitat. This means that there is the greatest probability of invasive plant spread, but there may be fewer impacts to sensitive species and their habitat associated with the increases in invasive species due to their already being present, and the suitable habitat for sensitive species already being potentially in compromised condition due to human activities associated with the

WUI. Project Design Features and the ***Pre-Treatment*** Checklist would be followed in order to assure implementation of projects stay in compliance with and consistent with the Forest Plan (Appendix B of the Final EIS).

The residual effects from this alternative are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

Sensitive Species within Alternative 3 Area

One of the ten sensitive species (*Botrychium paradoxum*), has potential to be present or its habitat within lightly disturbed microsites (old roads and road cuts) within or close to mesic coniferous stands above 10,500 ft. in elevation (to be conservative, areas > 8,500 ft. in elevation is spatially displayed on map below). Potential habitat for *B. paradoxum* could be found within aspen, spruce-fir, lodgepole and cool-moist mixed conifer cover types in alpine and subalpine zones. 88% of the potential affected area for Alternative 3 occurs above 8,500 ft. in elevation. Of that, 57 % occurs on west, northwest, north, northeast, and east facing slopes and tends to be more mesic. Figure 36 identifies new roads outside PTA's (does not include decommissioned or reconstructed) above 8,500 ft. and potential affected areas above 8,500 ft. that have a west, northwest, north, northeast, or east facing slope. There are no hazard tree treatments that occur at this elevation (and above) with these aspects (west, northwest, north, northeast, and east). Existing roads (new, decommissioned or reconstructed) are also identified inside and outside of PTA's for all elevations (does not include haul roads). Field surveys for *Botrychium paradoxum* should focus on these habitat areas but not limited to (Figure 36), as most often *Botryichium* species occur in microsites that may occur within these habitat areas. These microsites can be difficult if not impossible to identify with GIS data. Appropriate design features would be applied to protect suitable habitat for sensitive species based on best available science if found within treatment areas.

Another sensitive species, *Macahaeranthera coloradensis*, is most likely found in microsites within the proposed Alternative 3 project area. This species inhabits mountain parks, slopes, rock outcrops and dry tundra at elevations ranging from 8,500 – 12,500 ft. *Macahaeranthera coloradensis* prefers exposed substrates of calcareous, sedimentary and volcanic origin, and it may rely on periodic natural disturbances to maintain its open habitat. These habitat locations are too difficult to identify with GIS data.

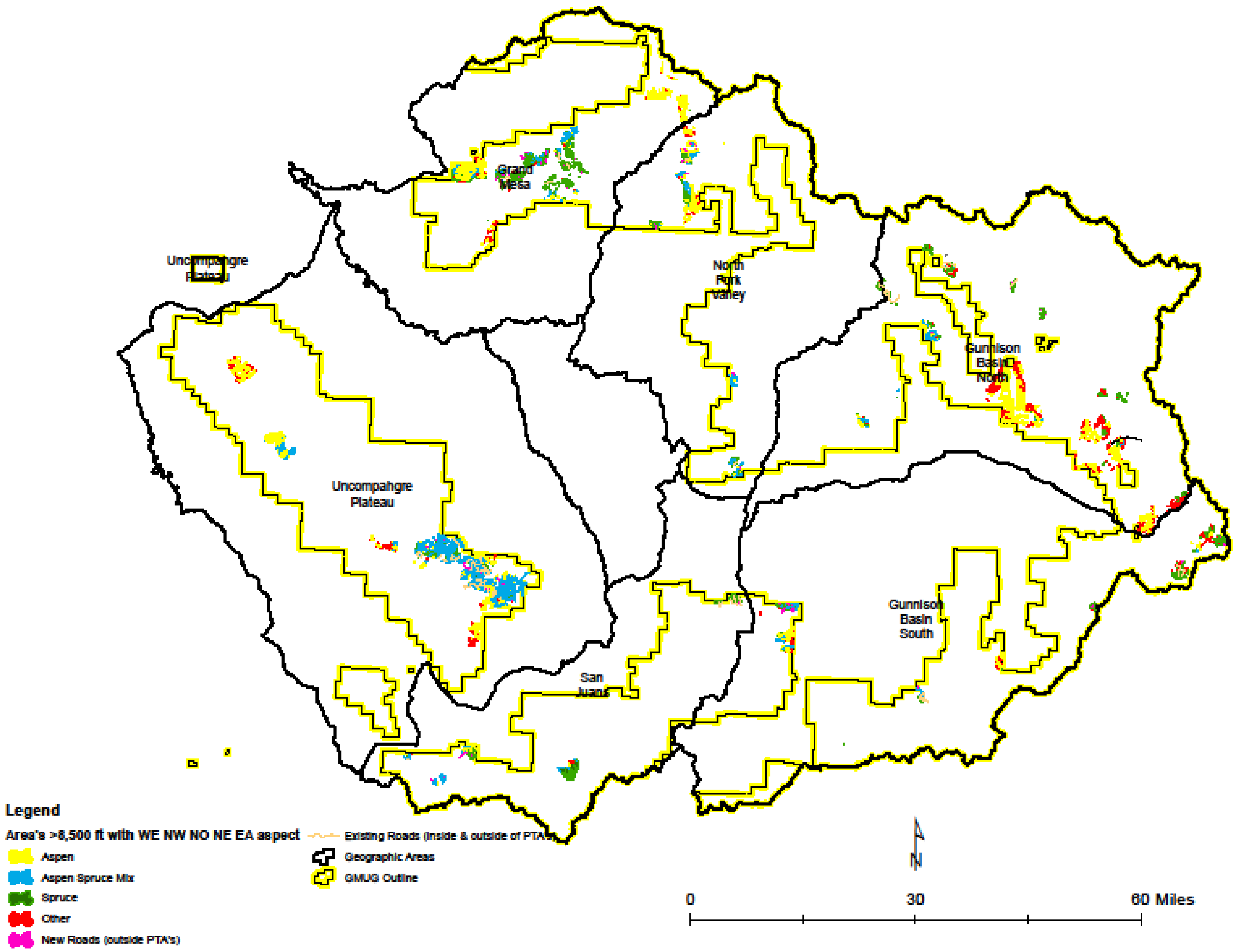


Figure 36 Species Cover and new roads outside PTA's (does not include decommissioned or reconstructed) above 8,500 ft. in elevation that occur on WE,NW,NO,NE,and EA aspects. Existing roads (new, decommissioned or reconstructed) include all elevations inside and outside of PTA's (does not include haul roads).

The total acres within the potential affected area of Alternative 3 that spatially overlap fen, wetland, riparian, or waterbodies is 3,575 (<1% of the total potential affected areas). Of those acres, 1% have a fen component, wetland 1%, riparian 95%, and waterbodies 3%. There are 293 acres of aquatic habitat features that overlap Potential Treatment Areas of which 77% occurs within non-commercial burn and mechanical treatment locations (Table 20). Prior to implementation, field surveys would verify presence or not of any threatened or sensitive plant species occurrences or where suitable habitat may be present in project areas. See Figure 37 for the extent of aquatic habitat features within the proposed action's maximum footprint. Appropriate design features would be applied to protect any threatened or sensitive species or suitable habitat found within treatment areas based on best available science (Appendix B of the Final EIS).

Seven of the ten sensitive species (*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor*) have the potential to be present or their habitat within wetland/fen areas. One of the ten sensitive species (*Astragalus leptaleus*) is most likely to occur in moist swales and riparian meadows. Most of these areas occur within riparian areas. The above species grow in habitats that are often wet and have standing water or high water tables. These habitat types are sensitive to ground disturbing activities and can be negatively impacted from activities occurring above, adjacent to, or within Legal and regulatory limitations on soil disturbing activity in these areas will reduce the potential for direct impacts. In the Forest Service, wetlands are surrounded by a buffer called the *water influence zone* (USDA Forest Service 2006). Since these laws and regulations severely restrict any activities in wetlands and limit activities in the water influence zone around them, activities implementing this project will avoid wetlands. Design criteria have been written for this project that avoids activities in wetlands (WQSP-2A, Appendix B of the Final EIS).

Field survey should not be limited to the aquatic habitat features spatially identified on map below, but rather areas to consider when conducting field surveys (Figure 37). Appropriate design features would be applied to protect any threatened or sensitive species or suitable habitat found within project area based on best available science (Appendix B of the Final EIS).

Table 20 “Areas within the proposed action where design features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be applied” (Appendix B of the Final EIS).

		Potential Affected Areas							
		Priority Treatment Areas							
		Commercial Treatment			Non-commercial Treatment				
Geographic Area	**Category**	**Resiliency**	**Salvage**	**Combination Resiliency/Salvage**	**Burn and Mechanical**	**Mechanical Only**	**Hazard Trees (Resiliency/Salvage)**	**New Roads Outside PTA's**	**Total Acres**
Grand Mesa	Fen	2		9			2		**13**
	Riparian	91	0	47	326	45	53	1	**562**
	Water	14	0	16	14	1	2	0	**46**
	Wetland	1	0	1	1		0		**3**
Gunnison Basin North	Fen						0		**0**
	Riparian	92	6	16	924		200	2	**1240**
	Water	1			14		1		**16**
	Wetland				2		1		**2**
Gunnison Basin South	Fen						0		**0**
	Ripaian	17	3	14	260		145	0	**440**
	Water			0	1		1		**1**
	Wetland			0	11		2		**13**
North Fork Valley	Riparian	102		16	215	10	118	1	**461**
	Water	3		1	6	0	1		**10**
	Wetland	2					0		**2**
San Juans	Fen	8		1			1	1	**10**
	Ripaian	13		28	2		35		**78**
	Water		0	1			0		**1**
	Wetland	6		3			0		**9**
Uncompahgre Plateau	Fen						1		**1**
	Riparian	39	1	65	446		69		**620**
	Water	2		1	31		5		**39**
	Wetland			1	9				**10**
Grand Total Acres		**391**	**11**	**220**	**2259**	**55**	**634**	**4**	**3575**

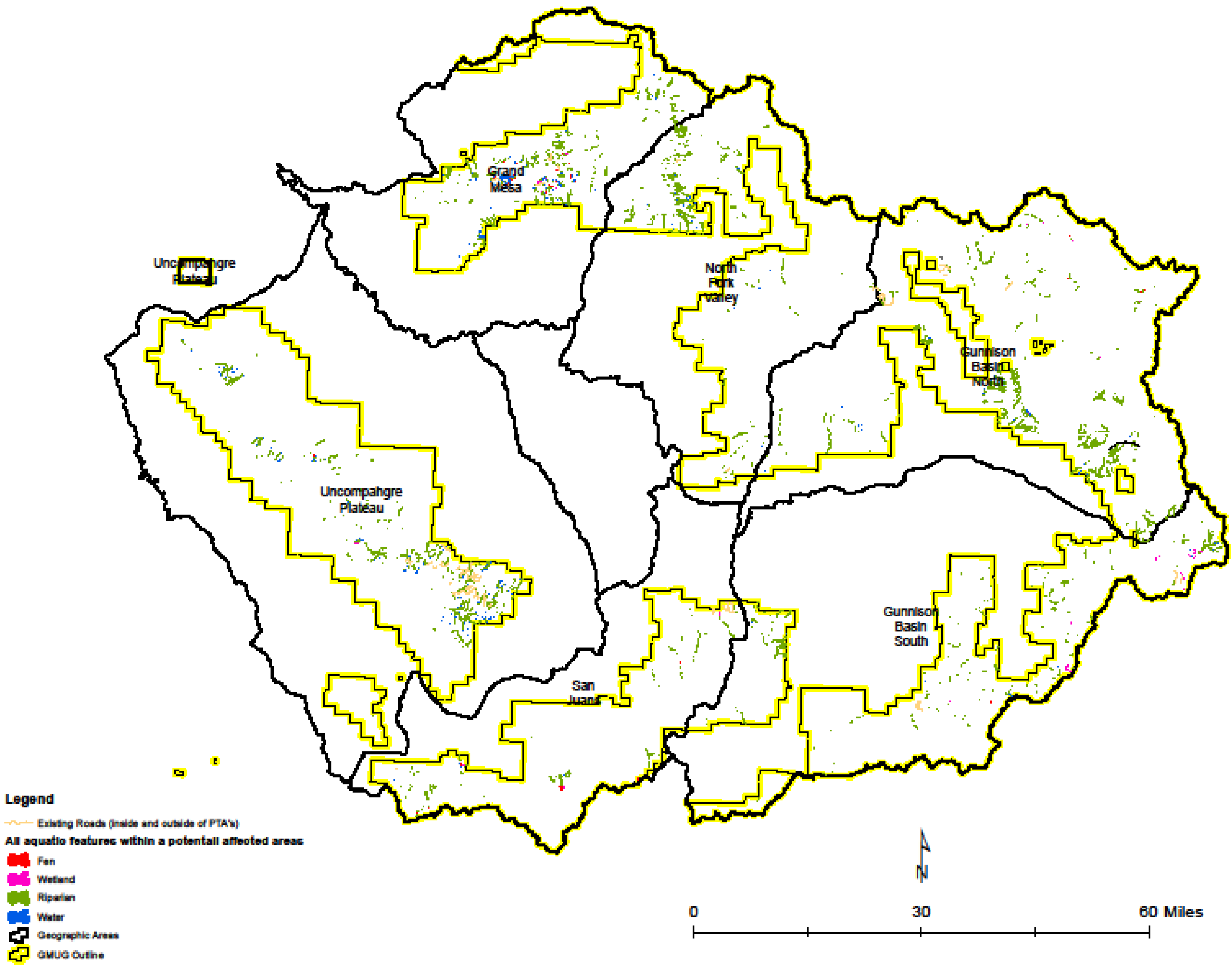


Figure 37. All fen, wetland, riparian, and waterbodies (aquatic habitat features) that occur within the proposed action areas. (Johnston and others 2012).

Hazard Tree Treatments

There will be 634 acres of hazard tree treatment within aquatic habitat features (18%). Design feature have been established to minimize the impacts and hence decrease the residual effects of project associated activities within and adjacent to riparian habitat (Appendix B of the Final EIS). The ideal buffer around fens and their associated wetlands is 100 feet minimum from the outer edge of the wetland complex which defines the ideal water influence zone (WIZ) and no harvest or mechanical travel should occur within 100 ft. of that WIZ (WQSP-2A Appendix B of the Final EIS). Wetlands ≥ ¼ acres ideal buffer is 100 ft. from edge and restricted activity is 50 ft. from WIZ and for seeps/springs/wetlands ≤ ¼ acres ideal buffer should be 50 ft. from source or edge with restricted activity 25 ft. from WIZ (WQSP-2A, Appendix B of the Final EIS). Riparian systems vary depending on if the system is perennial, intermittent or ephemeral. Perennial systems buffer is 100 feet from stream bank with restricted activities 50 ft. from WIZ, 50 ft. from intermittent stream and ponds bank or high water mark with restricted activity 25 ft., and ephemeral streams and swales is 25 ft. from edge (WQSP-2A, Appendix B of the Final EIS).

Design features were developed in response to the foreseeable adverse impacts to sensitive species (Table 17, Appendix B of the Final EIS). Design feature development and emphasis was placed on reducing, if not eliminating impacts that were likely to lead to losses in viability. The residual effects from this treatment are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

New Road Construction

There will be less acres of new roads constructed outside PTA's (does not include decommissioned or reconstructed roads) in Alternative 3 (169 acres) in comparison to alternative 2 (213 acres). Within the 20 ft. buffered areas on either side of new road (outside PTA's), there is approximately 4 acres of aquatic habitat features that spatially overlap areas proposed for new road construction. For new roads inside the PTA's, aquatic habitat features were lumped into treatment areas.

For the purpose of this section, I will consider all new roads (new, decommissioned, and reconstructed inside and outside of PTAs, buffered on either side by 20 ft.). All roads combined (excluding haul roads) encompass approximately 666 acres (Figure 38), less than half the acres for roads occurring within this alternative than for alternative 2 (1,425 acres). Road activities are likely the greatest contributor to invasive plant risk for this project (Birdsall and others 2012) [please refer to the Invasive plant risk assessment in the project record for detailed description]. New road construction also results in localized, but intense ground disturbance. Road use and construction can alter hydrologic function. Roads can result in water diverting into a different course. Roads contribute to heightened sedimentation levels (Gucinski and others 2001), which, if occurring upslope from a fen, could result in sediment accumulating in the fen. The 666 acres of proposed new, decommissioned, and reconstructed roads is the maximum impact scenario. Not all new roads will be constructed at the same time but rather over the life of the project (10 - 12 years). New roads (inside and outside of the PTA's) will only be used by the purchaser and for administration use only (no public use at any time). Approximately 70% of the new roads will be closed immediately after completion of the sale, and all constructed roads will be decommissioned within 5-years of sale closure. Existing roads that are re-aligned due to resource concern will be retained as part of the Forest Transportation system following decommissioning of the old route.

Design features have been established to minimize overall impacts and decrease the effects of treatment-associated activities within and adjacent to riparian habitat (Table 17, Appendix B of the Final EIS). Design feature development and emphasis was placed on reducing, if not eliminating impacts that were likely to lead to losses in viability. The residual effects from this activity are within the range of alternatives described in the ***direct***, ***indirect***, and ***cumulative*** effects under effects common to all alternatives.

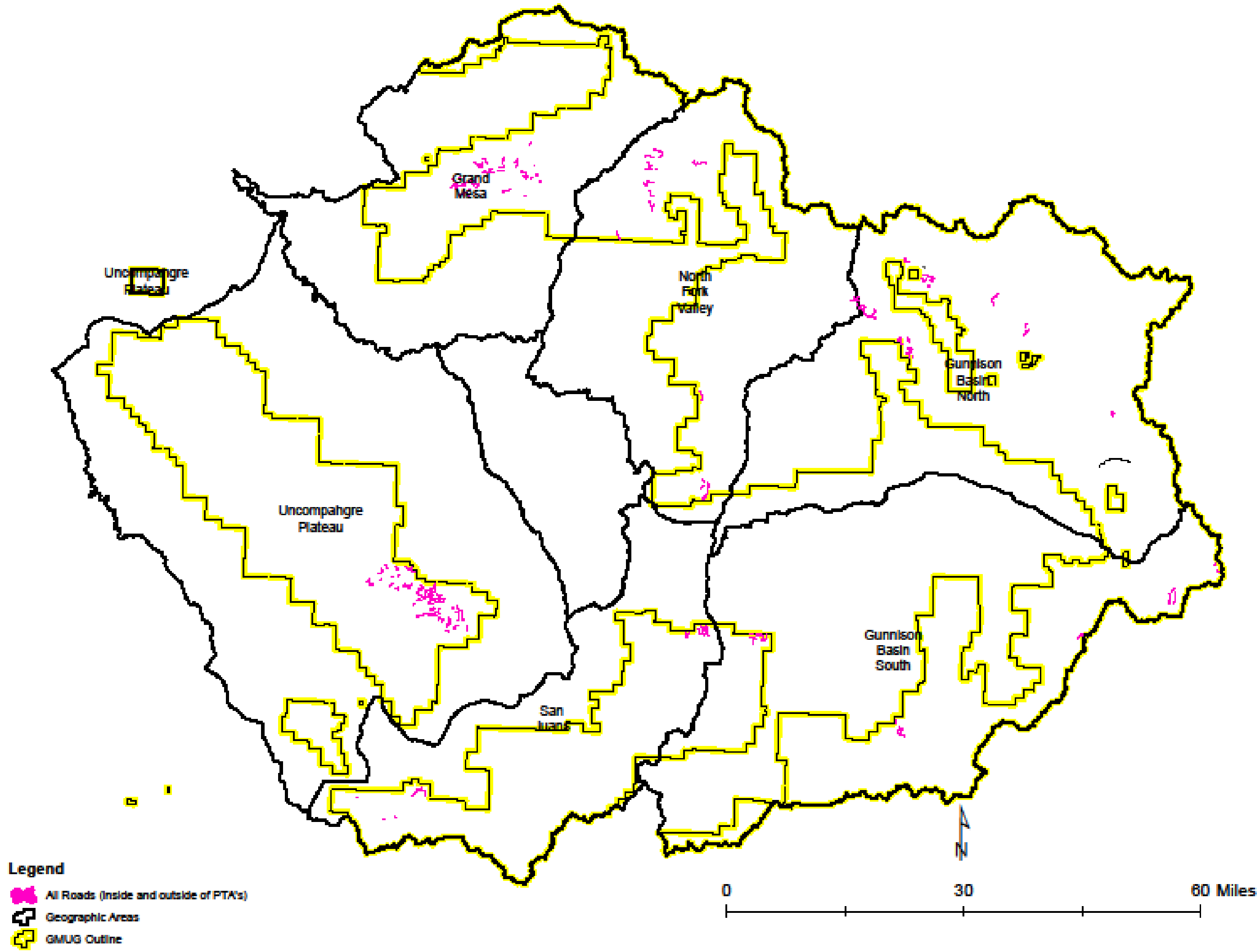


Figure 38. All new roads (new, decommissioned, and reconstructed) buffered 20 ft. on either side, inside and outside Priority Treatment Area (haul roads excluded).

Effects to Sensitive Species

The following is a description of the more likely residual effects per species, considering appropriate application of design features (Table 17, Appendix B of the Final EIS). Surveys would be conducted during treatment layout to assess presence or absence (FSSP-2A, Appendix B of the Final EIS).

Astragalus leptaleus

Direct Impacts. Direct effects are anticipated to be within the range of those discussed in alternative 2.

Indirect Impacts. Indirect effects are anticipated to be within the range of those discussed in alternative 2.

Cumulative Impacts. Cumulative effects are anticipated to be within the range of those discussed in alternative 2.

Botrychium paradoxum

Direct Impacts. Direct effects are anticipated to be less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse direct impacts to individuals and populations.

Indirect Impacts. Indirect effects are anticipated to be less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse indirect impacts to individuals and populations.

Cumulative Impacts. Cumulative effects are anticipated to be less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse cumulative impacts to individuals and populations.

Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, and Utricularia minor

Direct Impacts. Direct effects are anticipated to be within the range of those discussed in alternative 2.

Indirect Impacts. Indirect effects to *Carex diandra*, *Drosera rotundifolia*, *Eriophorum chamissonis*, *Eriophorum gracile*, *Salix candida*, *Sphagnum angustifolium* and *Utricularia minor* may be slightly lower with alternative three, as the densities of activities restricted to the WUI, will only impact slightly fewer potential fens, and potential fen acres. The increases in concentrations of these activities may lead to greater levels of sedimentation and hydrologic alteration, though adherence to design features will reduce the potential for substantial long term impacts to the viability of these species.

Cumulative Impacts. Cumulative effects are anticipated to be slightly less than those discussed in alternative 2.

Machaeranthera coloradoensis

Direct Impacts. Direct effects are anticipated to be less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse direct impacts to individuals and populations.

Indirect Impacts. Indirect effects are anticipated to be less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse indirect impacts to individuals and populations.

Cumulative Impacts. Cumulative effects are anticipated to be in the range, though less than those discussed in alternative 2. The lower number of temporary roads, and road reconstruction miles will likely reduce the potential for adverse cumulative impacts to individuals and populations.

SUMMARY OF DETERMINATIONS

Alternative 1: No Action

It is our determination that Alternative 1 will have **no effect** on *Carex diandra, Drosera rotundifolia, , Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor, Astragalus leptaleus, Machaeranthera coloradoensis,* and *Botrychium paradoxum.*

Alternative 2: Proposed Action

With implementation of Alternative 2 a determination of **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability** is made for *Botrychium paradoxum* due to the potential for widespread impacts to undetectable individuals and their suitable habitat. This species is not likely to trend toward federal listing as a result of the proposed action, due to their widespread distribution. It is our determination that implementing Alternative 2 **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability** for *Machaeranthera coloradoensis,* based on the species occurring on road systems and adjacent to areas that could be impacted.

It is our determination that implementing Alternative 2 **may adversely impact individuals, but is not likely to result in a trend toward Federal listing or loss of viability** for *Carex diandra, Drosera rotundifolia,, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor,* and *Astragalus leptaleus,* based on detailed design criteria that protect their habitat, wetlands and fens (Appendix B of the Final EIS).

Adapted Treatment Type

The above effect determination considers current stand condition and proposed actions within SBEADMR activity areas. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. If this occurs, the extent of potential direct and indirect effects to suitable habitat and potentially occupied suitable habitat for sensitive species will be greater.

Implementation of projects in future must adhere strictly to the proposed design features and policy standards discussed in this document to reduce adverse impacts and minimize or reduce direct and indirect impacts (Appendix B of the Final EIS). Following the design features and policy standards, changes in treatment type should not change the effect determination for “future” (present – 10-12 years) with adapted action. Allowing for adequate planning time to analyze and develop site specific recommendations and appropriate protection measures will be critical.

Protection provided within the design criteria (Table 17, Appendix B of the Final EIS) and standards should allow the effect determination to remain unchanged for any sensitive species. Implementing adapted action for alternative 2 a determination of **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability.** Following Design Criteria’s and adhering to policy standards will prevent individuals to trend toward Federal listing or loss of viability.

Alternative 3: WUI Alternative

It is our determination that implementing Alternative 3 **may adversely impact individuals, but is not likely to result in a trend toward Federal listing or loss of viability** for *Carex diandra, Drosera rotundifolia, , Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor, Astragalus leptaleus, Machaeranthera coloradoensis,* and *Botrychium paradoxum.*

Adapted Treatment Type

The above effect determination considers current stand condition and proposed actions within SBEADMR activity areas. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. If this occurs, the extent of potential direct and indirect effects to suitable habitat and potentially occupied suitable habitat for sensitive species will be greater.

Implementation of projects in future must adhere strictly to the proposed design features and policy standards discussed in this document to reduce adverse impacts and minimize or reduce direct and indirect impacts (Appendix B of the Final EIS). Following the design features and policy standards, changes in treatment type should not change the effect determination for "future" (present – 10-12 years) with adapted action. Allowing for adequate planning time to analyze and develop site specific recommendations and appropriate protection measures will be critical.

Protection provided within the design criteria (Table 17, Appendix B of the Final EIS) and standards should allow the effect determination to remain unchanged for any sensitive species. Implementing adapted action for alternative 3 a determination of **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability.** Following Design Criteria's and adhering to policy standards will prevent individuals to trend toward Federal listing or loss of viability.

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PERSONAL COMMUNICATIONS

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APPENDIX A: BOTANY IMPACTS LOGIC

Introduction

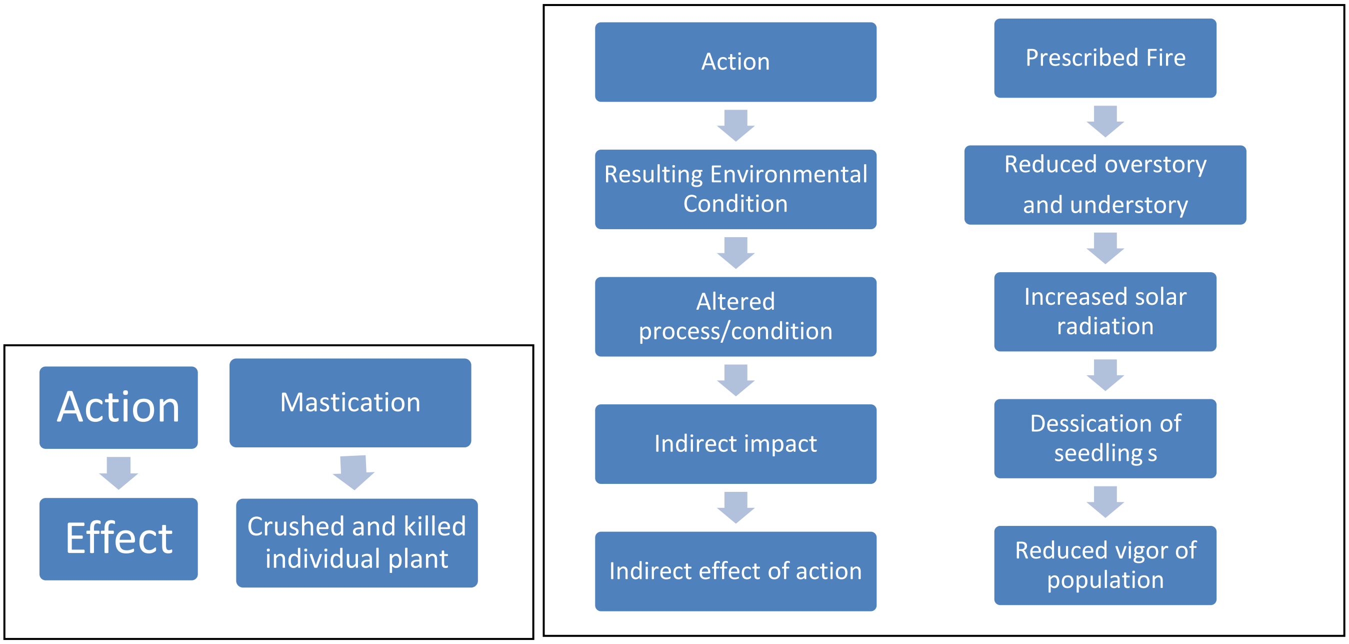
The primary goal of this portion of analysis is to present the range of potential impacts to suitable habitat and potentially occupied suitable habitat for sensitive species. The information is presented in the following order:

a) Actions are identified from the action alternatives that have the potential to impact known populations or suitable habitat;
b) Explanations of the pathways for direct and indirect impacts are analyzed with emphasis on the post-action resulting environmental condition;
c) Analysis of the potential pathways for impacts and subsequent effects as a result of the actions associated with the action alternatives; and analysis of the resulting environmental conditions and the pathways of impacts to individual plant vigor and suitability of habitat.
d) Design criteria to minimize the impacts and hence effects of project associated activities.

Twenty- three actions were identified from the action alternatives that have the potential to impact sensitive species. These actions are:

1. Increased vehicular traffic and moving of equipment
2. Staging areas
3. Managed wildfire
4. Prescribed fire (broadcast including aerial ignition)
5. Prescribed fire (pile burning)
6. Fireline construction
7. Mastication
8. Burning of masticated or chipped residuals
9. Hand cutting of vegetation, cut and chunk
10. Chipping of material
11. Coppice cutting (for aspen regeneration only)
12. Replanting and site preparation for replanting (for Engelmann spruce only)
13. Roller chopping (crushing and chopping)
14. Hydro-axing (mastication)
15. Timber harvest using mechanical equipment
16. Cut and chunk (see hand cutting of vegetation)
17. Chipping (see chipping of material)
18. Hand-pile burn (see prescribed fire, pile burning)
19. Road construction and reconstruction, including temporary roads
20. Road de-commissioning
21. Dust abatement
22. Road maintenance
23. Invasive plants treatment

Impacts to plants can be a direct result of the action (see Fig. 1A below) or may result in a changed environmental condition that alters a biological or physical process that results in the actual (indirect) impact to the individual species (see Fig. 1B below).



A B

Figure A-1: A. Pathway of effects for direct impacts. B. Pathway of effects for indirect impacts.

The altered process or condition can result in a further (secondary) alteration to a process or condition that then results in the actual indirect impact. Both direct and indirect impacts can result in adverse or beneficial effects that ultimately affect the overall capacity of the species to persist in either the context of a single occurrence or as a biological entity.

Actions associated with project activities and resulting environmental conditions

The following is an itemization of actions and resulting conditions. The items underlined and in bold are direct impacts with direct effects generally resulting in mortality for individuals or occurrences. The items in regular font are indirect impacts and will be discussed below in Pathways for Indirect Impacts.

A. General project activities
    1. Increased vehicular traffic and moving of equipment
        - Introduction of invasive plant species
        - Soil disturbance
        - Dust
        - [air] pollution
    2. Staging areas
        - Soil disturbance/compaction
        - Toxicity- chemical spills [fuel primarily]
        - Crushing of TES plant individuals or occurrences
        - Introduction and establishment of invasive plant species

B. Fuels treatment/management
    3. Managed wildfire (part of another decision notice)
    4. Prescribed fire (broadcast including aerial ignition)
        - Soil heating
        - Removal of overstory and understory vegetation
        - Alteration of successional pathways
        - Burnt vegetation, litter/duff layer and soil
        - Nonlethal to lethal heating of plants individuals or occurrences or seep/spore bank
    5. Prescribed fire (pile burning)
        - Soil disturbance
        - Soil heating (size of piles)
        - Lethal heating of mycorrhizae
        - Burnt vegetation, litter/duff layer and soil
        - Lethal heating of individuals or occurrences of plants or seed/spore bank
    6. Fireline construction
        - Soil disturbance [use of bull dozers and hand] (localized/intense)
        - Soil compaction [bull dozers]
        - Introduction of invasive plant species
        - Crushing of plant individuals or occurrences
    7. Mastication
        - Soil compaction
        - Removal of overstory and understory vegetation
        - Soil disturbance
        - Introduction of invasive plant species
        - Physical alteration of biomass/fuels profile
        - Alteration of successional pathways
        - Crushing of individuals or occurrences of plants
    8. Burning of masticated or chipped residuals
        - Soil heating (mychorrhizae)
        - Lethal heating of individual plants or occurrences or seed/spore bank
        - Burnt vegetation, litter/duff layer and soil
    9. Hand cutting of vegetation

- Soil disturbance/compaction
- Introduction of invasive plant species
- Physical alteration of biomass/fuels profile
- Removal of overstory and understory vegetation
- Crushing of individuals or occurrences of plants

10. Chipping of material
    - Introduction of invasive plant species on equipment
    - Physical alteration of the biomass/fuels profile
    - Suppression of seed bank
    - Spread of invasives through spreading chips

C. Timber- general

11. Coppice cutting- clearcutting
    - Soil disturbance/compaction
    - Introduction of invasive plant species
    - Physical alteration of biomass/fuels profile
    - Removal of overstory and understory vegetation
    - Crushing of individuals or occurrences of plants
12. Replanting/prep
    - Soil disturbance
    - Alteration of successional pathways
    - Introduction of nonnative invasive plants/pathogens on equipment or in soil

D. Timber – mechanical

13. Roller chopping (crushing and chopping)
    - Soil disturbance
    - Introduction of invasive plant propagules on equipment or imported materials
    - Crushing of individuals or occurrences of sensitive plants
    - Soil compaction [hydrology, mychorrhizal relationships]
    - Removal of overstory and understory vegetation
    - Alteration of hydrologic systems through soil compaction or water diversion due to microtopographic changes[diversion of surface water flow]
    - Erosion [increased sedimentation in fens?]
    - Alteration of biomass profile (increased fuels on ground)
14. Pile burning (see under fuels)
15. Hydro-axing (see mastication under fuels)
16. Cut-equipment
    - Soil disturbance
    - Introduction of invasive plant propagules on equipment or imported materials
    - Crushing of individuals or occurrences of sensitive plants
    - Soil compaction [hydrology, mychorrhizal relationships]
    - Removal of overstory and understory vegetation
    - Alteration of hydrologic systems through soil compaction or water diversion due to microtopographic changes[diversion of surface water flow]
    - Erosion [increased sedimentation in fens?]

E. Timber – non mechanical

17. Cut and chunk (see hand treatment under fuels)
18. Chipping (see chipping under fuels)
19. Hand-pile burn (see prescribed fire [piles] under fuels)

F. Roads

20. Road construction/reconstruction [temp roads included]
    - Soil disturbance

- Introduction of invasive plant propagules on equipment or imported materials
- Crushing of individuals or occurrences of sensitive plants
- Soil compaction [hydrology, mychorhizal relationships]
- Removal of overstory and understory vegetation
- Alteration of hydrologic systems through soil compaction or water diversion[diversion of surface water flow]
- Erosion [increased sedimentation in fens?]
- Increase potential for recreation/illegal trespass
- Replanting/reseeding
- Fragmentation/isolation of populations [not sure how substantial of an impact for plants, but potentially for pollinators. Not sure that the scope of this project warrants discussion]
- Road de-commissioning
- Soil disturbance
- Introduction of invasive plant propagules on equipment or imported materials
- Alteration of hydrologic systems through soil water diversion[diversion of surface water flow]
- Erosion [increased sedimentation in fens?]
- Replanting/reseeding

21. Dust abatement
    - Toxicity (substances used for dust abatement)
22. Road maintenance
    - Soil disturbance
    - Introduction of nonnative invasive plants
    - Crushing/removal of individuals or occurrences of sensitive plants

G. Invasive species treatment

23. Pre-project invasives treatment- toxicity
24. Post-project invasives treatment- toxicity

Pathways for Indirect Impacts

Eleven resulting environmental conditions that lead to adverse or beneficial impacts to sensitive plants suitable and potentially occupied suitable habitat have been identified for this project based on the eleven actions associated with project related activities. The twenty-two actions associated with the action alternatives can result in similar resulting conditions, for example, both hand thinning and mastication would result in soil disturbance. The magnitude of the resulting condition and hence the magnitude anticipated indirect or direct impacts will vary from different methods of treatment and project associated actions.

Table A-1. Environmental conditions that lead to adverse or beneficial impacts.

Environmental condition	Notes
Invasive plants	Includes introduction and spread of invasive plants
Soil disturbance	Includes erosion, alteration of hydrologic systems, and dust
Pollution	
Soil compaction	Includes alteration of hydrologic systems
Toxicity	Includes chemical spills
Removal of over/understory vegetation	
Alteration of successional pathways	
Removal of groundcover (veg, litter, duff)	
Lethal soil heating	
Physical alteration of biomass/fuels profile (increased fuels on ground)	
Physical fragmentation/isolation	

Pollution

Pollution in this context is referring to emissions from motorized engines, and is associated with most of the project activities, if not all, as vehicles will be used to access sites. In addition, motorized equipment will be used in many treatment types including aerial ignitions, timber harvest equipment, etc.

Table A-2. Impacts and species affected from pollution.

Condition resulting from action	Altered process/condition	Secondary Altered process/condition	Indirect Impact	Indirect Effect[17]	Impact type	Species affected
Pollution	Increase of pollutants including ozone and other compounds	Tropospheric ozone	Necrosis, reduced	RV	-	All, especially lower elevational species]
		Acid Rain		RV	**-**	All

Fragmentation or isolation of habitat and or populations

The physical creation of barriers is associated with several project activities (and could be linked to others with habitat alteration). The main action with any substantial contribution to this environmental condition is the construction of new roads and the reconstruction of closed or decommissioned roads.

Table A-3. Impacts and species affected from fragmentation or isolation.

Condition resulting from action	Altered process/condition	Secondary Altered process/condition	Indirect Impact	Indirect Effect[18]	Impact type	Species affected
Physical fragmentation of the landscape	Fragmentation of physical habitat	Isolation of once continuous population	Decrease in pollination for plants dependent on outcrossing	RV	-	All
			Reduced gene flow	RV	-	All
	Changes in pollinator behavior	Reduced pollinator visits	See above			
	Disruption of mycorrhizal networks	Decreased vigor of mycorrhizal symbionts	Decreased nutrition to sensitive	RV	-	*Botrychium paradoxum*
			Decreased nutrition to host organisms that are habitat constituents.	HL	-	*Botrychium* . *paradoxum*

[17] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained
[18] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Soil Disturbance

Soil disturbance is associated with eight treatment associated actions (see list below). The difference in the magnitude of soil disturbance depends on the frequency of the actions associated with the treatment, and the capacity of the agents of the action in direct contact with the ground to disturb the soil. The following actions that have the capacity to result in soil disturbance:

1. Fireline construction: Tools used to create fire line remove litter/duff layers and create linear features of bare soil and could result in disturbance of mineral soils as well.
2. Mastication: The heavy machinery used to perform mastication treatments will result in soil disturbance.
3. Road reconstruction
4. Hand cutting of vegetation: The foot and vehicular traffic associated with this action will result in areas of disturbed soil.
5. Chipping of material: The movement of the machinery associated with this treatment application will result in areas of localized soil disturbance.
6. Pile construction and burning: The foot and vehicular traffic associated with this action will result in areas of disturbed soil.
7. Increases of vehicular traffic due to project related activities
8. Sporax® application: The foot and vehicular traffic associated with this action will result in areas of disturbed soil.

Table below displays how soil disturbance indirectly impacts and affects sensitive plants. The arrow indicates that the initial altered process or resultant environmental condition results in the indirect impact.

Table A-4. Impacts and species affected from soil disturbance.

Condition resulting from action	***Altered process/condition***	***Secondary Altered process/condition***	***Indirect Impact***	***Indirect Effect[19]***	***Impact type***	***Species affected***
Disturbed Soil	Creation of bare soil	Increased erosion and loss of soil	Increased sedimentation [inhibits peat formation and fen function]	HL/RV [potential for direct impact by mortality through covering individuals]	-	*Carex diandra, Drosera rotundifolia, E. chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
			Creation of suitable habitat for invasive species	HL	-	all
			Creation of suitable habitat for disturbance follower sensitive species	HG	+	*Botrychium paradoxum* [may be delayed recruitment]
		Increases in soil heating resulting in decreased soil moisture	Increased desiccation of sensitive plants requiring mesic[20] conditions	RV	-	*Carex diandra, Drosera rotundifolia, E. chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
		→	Creation of suitable habitat for invasive species	RV/HL	-	All
		→	Creation of suitable habitat for disturbance follower sensitive species	HG	+	*Botrychium paradoxum* [may be delayed recruitment]; *Machaeranthera coloradoensis*
		Increased dust in environment	Reduced capacity for photosynthesis	RV	-	All
			Reduced pollination capacity (dust on stigmas)	RV	-	NEED TO CHECK IF ANY SPECIES ARE NOT OUTCROSSERS
	Scarification[21] of seedbank	→	Germination of sensitive individuals	IV	+	ARE ANY SPECIES KNOWN TO HAVE SCARIFICATION REQTS?
		→	Germination of Invasive plants	RV/HL	-	ALL
	Disruption of mycorrhizal networks	Decreased vigor of mycorrhizal symbionts	Decreased nutrition to sensitive	RV	-	*Botrychium paradoxum*
			Decreased nutrition to host organisms that are habitat constituents.	HL	-	*Botrychium paradoxum*

[19] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

[20] mesic= "moist loving"

[21] Scarification: Some seeds require physical abrasion to germinate.

Canopy Cover Reduction

Canopy cover reduction is associated with the proposed treatments, which include mastication, prescribed fire and hand thinning. The magnitude of the impacts from the resulting condition depends on the amount of canopy cover reduction. Target levels of post treatment canopy cover vary depending on the affected vegetation type.

Table A-5. Impacts and species affected from canopy cover reduction.

Condition resulting from action	***Altered process/condition***	***Secondary Altered process/condition***	***Indirect Impact***	***Indirect effect[22]***	***Impact type***	***Species affected***
Removal of overstory and understory	Increased solar radiation	Increased evapotranspiration	Increased desiccation	RV	+	*Botrychium paradoxum, Astragalus leptaleus*
			Increased growth capacity from increases in photosynthesis	IV	+	Not sure if this applies, though the Botrychium's may benefit from openings.
		Changes in microclimate	Elimination of suitable habitat for sensitive plant	HL	-	*Botrychium paradoxum, Astragalus leptaleus, Machaeranthera coloradoensis*
			Creation of suitable habitat for sensitive plant species.	HG	+	*Botrychium paradoxum, Astragalus leptaleus.*
			Creation of suitable habitat for invasive plant species	HL	-	All, especially *Botrychium paradoxum, Machaeranthera coloradoensis*
	Reduction in fuel loading	Reduced probability of high severity wildfire	Reduction in probability of wildfire burning individuals, and/or creating/destroying habitat.	IV, HL, HG	+/-	All
	Increase in recreational access	Direct trampling from increased foot or OHV traffic	Death/injury to individual sensitive plants	RV	-	All
		Introduction of invasive plant species	SEE INTRODUCTION OF INVASIVE PLANT SPECIES	RV, HL	-	All
		Increases in disturbances in habitat	Creation/Elimination of suitable habitat for sensitive species	HL/HG	+/-	*Botrychium paradoxum Machaeranthera coloradoensis*

[22] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Invasive Species

There were ninety nonnative species identified in the proposed treatment area. Of these, thirty were identified and having the potential for ecological harm. Of the thirty, seventeen species were mapped, the remaining thirteen were identified as too ubiquitous for mapping purposes (cite invasive species report, consider adding a map to this report).

Table A-6. Impacts and species affected from increases in invasive nonnative plant species.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect Impact***	***Indirect Effect***[23]	***Impact type***	***Species Affected***
Introduction/ Expansion of Invasive plant species[24]	Competition with native vegetation for resources (eg. nutrients, water, light, space)	→	Reduced resources for sensitive plants	RV, HL	-	All
	Alleleopathy/Toxicity	Changes in soil biota	Reduction in resources available to sensitive plants	RV, HL	-	All
		Direct toxicity to plant	See Toxicity	RV	-	All
	Alteration of the biomass structure and fuels profile	Changes in fire intensity	See Alteration of successional pathways	RV, HL	-	*Machaeranthera coloradoensis*
		Increased flammability			-	All, especially *Machaeranthera coloradoensis Botrychium paradoxum,*
	Changes in soil biota	→	Reduced availability of nutrients for sensitive plants	RV, HL	-	*Botrychium paradoxum Machaeranthera coloradoensis,Astragalus leptaleus*
	Changes in nitrogen cycling	Increases or decreases in nutrients in occupied and potentially occupied habitat	Reduction/Increase in availability of nutrients for sensitive plants	RV, IV, HL, HG	+/-	
	Alteration of the successional pathways	See Alteration of Successional Pathways		RV, IV, HL, HG	+/-	All
	Alteration of hydrologic regimes	→	Reduced availability of water for sensitive plants.	RV, HL	-	*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor Astragalus leptaleus*

[23] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

[24] Please refer to the Nonnative Invasive Plant Species Risk Assessment in the project file, herby incorporated by reference.

Altered Successional Pathways

Successional pathways are temporal patterns of vegetation changes-- trajectories in space and time resulting from disturbance events that shape structure and function of a plant community at a given time. For this discussion, it includes changes in plant community types or constituents of those plant communities. In a "naturally" functioning ecosystem the mechanisms or interactions that influence successional pathways include competition, inhibition (e.g., reduced solar radiation due to canopy closure), and facilitation (e.g.. habitat constituent creates favorable conditions for establishment). The disturbance type and regime of a given plant community alters the trajectory of these successional pathways. For the project area, fire was likely the dominant historic disturbance regime that was the primary force in shaping successional pathways. The absence of fire within the affected landscape combined with the land use history (i.e. logging, grazing, impacts from mining, recreational use, road construction, etc.) have caused great changes in natural successional pathways. These processes are complex and can have multiple potential trajectories that are rarely linear. By the time the theoretical framework had been developed so that these dynamic processes could be analyzed, the landscape affected by the proposed project was likely already so far outside the natural range of variability so as to make impossible a real understanding of the mechanisms and pathways of "natural" succession.

Table A-7. Impacts and species affected from alteration of the successional pathway.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect impact***	***Indirect Effect***[25]	***Impact type***	***Species affected***
Alteration of Successional Pathways	Reversion of vegetation to early successional	→	Creation of suitable habitat for early seral species	HG	+	*Botrychium paradoxum Machaeranthera coloradoensis*
		→	Elimination of habitat for late seral sensitive plant species	HL	-	?
		Creation of habitat for invasive species	Reduced site suitability for sensitive	HL	-	All, especially *Machaeranthera coloradoensis, Botrychium paradoxum*
	Changes in species composition	Changes in habitat constituents	Creation or elimination of suitable habitat for sensitive plants.	HL, HG	-/+	All, especially *Machaeranthera coloradoensis, Botrychium paradoxum*
	Increased vulnerability to other disturbance events which would cause the landscape to vary even further from the natural range of	Vegetative type conversion	Elimination of suitable habitat for sensitive plants.	HL, RV	-	All

[25] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Condition resulting from action	Altered process/condition	Secondary altered process/condition	Indirect impact	Indirect Effect[25]	Impact type	Species affected
	variation.					

Soil Compaction

There are several actions that could result in soil compaction, and thus alter the hydrologic regime in the project area. Soil compaction could occur from repeated passes by foot, machinery, or vehicles. The soil design features (See Hydrology design features) are meant to minimize this impact to negligible to minor, short-term and localized[26]. Adherence to these design features would reduce the adverse indirect impacts from this effect are likely to be none to negligible to sensitive plant and fungi species.

Table A-8. Impacts and species affected from soil compaction.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect impact***	***Indirect Effect[27]***	***Impact type***	Species Affected
Soil Compaction	Soil structure changes reducing infiltration or hydrologic function	Increased runoff and erosion/ sedimentation in fens	Reduced Suitability/sustainability of habitat for sensitive plants [especially fen species]	RV, HL	-	*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
		→	Reduced Suitability/sustainability of habitat for sensitive plants [especially wetland species]	RV, HL	-	*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor, Astragalus leptaleus*
	Pore space in soil decreased	Adverse impacts to soil microbes, especially mychorrhizae				*Botrychium paradoxum,* potentially others if mychorrhizal relationships are important.
	Crushing of underground plant parts	→	Injury to individuals	RV	-	*Botrychium paradoxum, Machaeranthera coloradoensis*

[26] Please refer to the Soils and Hydrology Specialist report for a full analysis of soil compaction potential with the I-5 Corridor project.

[27] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Fire consumed vegetation and litter and duff

The consumption of vegetation and the litter and duff layer due to fire results from the application of fire to either the landscape, or in discrete areas with pile burning.

Table A-9. Impacts and species affected from fire consuming vegetation and litter and duff..

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect Impact***	***Indirect Effect***[28]	***Impact type***	***Species affected***
Fire consumed vegetation, litter/duff	Consumption of individual sensitive individuals (top kill of perennials, total consumption of individual annual species and seed bank)	→	Death/injury of individual sensitive	RV	-	
		→	Stimulation of resprouting	IV	+	*Astragalus leptaleus*
		→	Injury to individual	RV	-	
	Consumption of litter/duff layer	Creation of bare soil	Creation of suitable habitat for sensitive	HG	+	?
			Elimination of suitable habitat for sensitive	HL	-	Do not think this will impact species
			Creation of suitable habitat for invasive species	HL	-	All, especially *Machaeranthera coloradoensis, Botrychium paradoxum Astragalus leptaleus*
			SEE DISTURBED SOIL (sedementaion, bare soil)	-		*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
	Release of nutrients	→	Increased nutrient availability for sensitive plant species	IV	+	*Machaeranthera coloradoensis, Botrychium . paradoxum, Astragalus leptaleus*
		→	Increased nutrient availability for invasive plant species	RV	-	All
	Stimulation of seed bank	→	Germination of sensitive individuals	IV	+	Are any of the species requiring this type of stimulation?
		→	Germination of Invasive plants	HL	-	All

[28] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Soil Heating

This condition results from the application of fire across the landscape, or in discrete areas such as occurs when piles are burned.

Table A-10. Impacts and species affected from soil heating.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect Impact***	***Indirect Effect[29]***	***Impact type***	***Species affected***
Soil Heating	Lethal heating of the seed/spore bank	→	Mortality of sensitive seed/spore bank.	RV	-	*Machaeranthera coloradoensis, Botrychium . paradoxum*
		→	Mortality of Invasive plant seed bank.	HG	+	All, especially *Machaeranthera coloradoensis, Botrychium . paradoxum*
	Lethal heating of underground portion of plants	Mortality of overstory and understory vegetation	SEE REMOVAL OF OVERSTORY AND UNDERSTORY			
		→	Mortality of individual sensitive plant	RV	-	*Machaeranthera coloradoensis, Botrychium paradoxum Astragalus leptaleus*
	Heat scarification of seed bank	Germination of Invasive seed bank	Increase in invasive plant species	RV	-	All [do any of the invasive have this known mechanism for germination?]
		→	Germination of sensitive seed bank	IV	+	Are any of the species requiring this type of stimulation?
	Lethal heating of soil microbes	Injury to mycorrhizal symbionts	Reduction in habitat suitability for sensitive plants	HL, RV	-	*Botrychium . paradoxum*
		Reduced soil nutrients/ performance				All
	Hydrophobic soil resulting in reduced infiltration	Increases in erosion				*Carex diandra, Drosera rotundifolia, Eriophorum . chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
		Decreases in water and nutrient availability				*Carex diandra, Drosera rotundifolia, Eriophorum . chamissonis, E. gracile, Kobresia simplicluscula, Salix candida, Sphagnum angustifolium, Utricularia minor*
	Loss of soil organic matter	Negative impacts to soil fertility, moisture, structure				All, especially *Botrychium paradoxum*

[29] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Physical alteration of biomass or fuels

Physical alteration of biomass and fuels profile is the resulting condition associated with treatments that alter the biomass and fuels in space (generally on a vertical plane). This is associated in the action alternatives with fire surrogate treatments such as mastication and hand thinning and pile burning. The altered biomass/fuels profile result in fire behavior that is outside the natural range of variability.

Table A-11. Impacts and species affected from physical alteration of biomass or fuels, looking at some of the potential resulting impacts and effects to sensitive plants with these treatment types both with and without follow up prescribed fire.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect Impact***	***Indirect Effect[30]***	***Impact type***	***Species affected***
Physical alteration of biomass/fuels profile	Increased biomass/fuel on ground	Increased C/N ratio for microbial processing resulting in reduced N availability	Reduction in suitability for sensitive plant and mychorrhizal species	RV, HL	-	
		Increased soil heating with prescribed fire	Increased mortality in residual vegetation	SEE REMOVAL OF OVERSTORY AND UNDERSTORY VEGETATION		
			SEE LETHAL SOIL HEATING			
		Suppression of seed bank expression	Reduced germination of sensitive	RV	-	
			Reduced germination of invasive plant species	IV	+	
		Increased soil moisture retention	Increase in suitability for sensitive plant and fungi species	IV	+	*Botrychium paradoxum*
		Smothering of perennial individuals	Reduced photosynthetic capacity for sensitive plants	RV	-	
	Reduced probability of high intensity crown fire	Reduced potential loss of canopy cover	Reduction in suitability for nonnative invasive plants	IV, HG	+	

[30] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

Toxicity

Toxicity is possible in the areas where chemical spills occur or $MgCl_2$ or $CaCl_2$ applied for dust abatement respectively.

Table A-12. Impacts and species affected from toxicity.

Condition resulting from action	***Altered process/condition***	***Secondary altered process/condition***	***Indirect Effect***	***Indirect Impact***[31]	***Impact type***	***Species affected***
Toxicity	Reduced performance of soil microbes	→		RV, HL	-	*Botrychium. paradoxum*
	Absorption of toxins by sensitive plants	→	Damage to individuals	RV	-	Most likely *Machaeranthera coloradoensis, Botrychium . paradoxum*

[31] RV=Reduced vigor; IV=Increased vigor; HL=Habitat lost; HG=Habitat gained

APPENDIX B: PLANT SPECIES MENTIONED

Name[1]	Code[2]	Common Names(s)
TREES		
Abies bifolia	ABBI3	subalpine fir
Fraxinus anomala	FRAN2	single-leaf ash
Negundo aceroides	NEAC	box-elder
Picea pungens	PIPU	blue spruce
Picea engelmannii	PIEN	Engelmann spruce
Populus angustifolia	POAN3	narrowleaf cottonwood
Populus balsamifera	POBA2	balsam poplar
Populus deltoides ssp. *wislizenii*	PODEW	Rio Grande cottonwood
Populus tremuloides	POTR5	quaking aspen
Populus × acuminata	POAC5	lanceleaf cottonwood
SHRUBS		
Alnus incana ssp. *tenuifolia*	ALINT	thinleaf alder
Betula glandulosa	BEGL	bog birch
Betula occidentalis	BEOC2	water birch
Crataegus rivularis	CRRI	water hawthorn
Crataegus saligna	CRSA2	willow hawthorn
Salix boothii	SABO2	Booth willow
Salix candida	SACA4	sageleaf willow
Salix. drummondiana	SADR	blue willow, Drummond willow
Salix geyeriana	SAGE2	Geyer willow
Salix glauca	SAGL	grayleaf willow
Salix gooddingii	SAGO	Goodding's willow
Salix ligulifolia	SALI	strapleaf willow
Salix lasiandra var. *caudata*	SALAC4	greenleaf willow
Salix lasiandra var. *lasiandra*	SALA5	Pacific willow
Salix monticola	SAMO2	mountain willow, serviceberry willow
Salix planifolia	SAPL2	planeleaf willow
Salix wolfii	SAWO	Wolf's willow
Salix bebbiana	SABE2	Bebb willow
Salix brachycarpa	SABR	barrenground willow
Salix exigua	SAEX	sandbar willow, coyote willow
Sclerocactus glaucus	SCGL	Colorado hookless cactus
Swida sericea	SWSE	red-osier dogwood
GRAMINOIDS		
Calamagrostis canadensis	CACA4	bluejoint reedgrass
Carex aquatilis	CAAQ	water sedge
Carex diandra	CADI4	lesser panicled sedge
Carex nebrascensis	CANE2	Nebraska sedge
Carex pellita	CAPE42	woolly sedge
Carex praeceptorum	CAPR22	early sedge
Carex scopulorum	CASC12	mountain sedge
Carex utriculata	CAUT	beaked sedge
Deschampsia cespitosa	DECE	tufted hairgrass
Eleocharis palustris	ELPA3	common spike-rush
Eleocharis quinqueflora	ELQU2	few-flower spike-rush
Eriophorum chamissonis	ERCH7	Chamisso's cottongrass
Eriophorum gracile	ERGR8	slender cotton-grass
Kobresia simpliciuscula	KOSI2	simple bog sedge
FORBS		
Aliciella sedifolia	ALSE11	stonecrop gilia, stonecrop gily-flower
Astragalus iodopetalus	ASIO2	violet milkvetch, purple milkvetch
Astragalus leptaleus	ASLE9	park milkvetch
Astragalus microcymbus	ASMI3	skiff milkvetch
Braya glabella	BRGL	smooth northern-rockcress, smooth rockcress, arctic braya
Calochortus flexuosus	CAFL	winding mariposa lily
Cardamine cordifolia		
Drosera rotundifolia	DRRO	roundleaf sundew
Epipactis gigantea	EPGI	stream orchid

Name[1]	Code[2]	Common Names(s)
Machaeranthera coloradoensis	MACO13	Colorado tansy-aster
Mertensia ciliata	MECI3	fringed bluebells
Neoparrya lithophila	NELI2	Bill's neoparrya
Phacelia submutica	PHSU6	De Beque phacelia
Physaria pulvinata	*	cushion bladderpod
Physaria scrotiformis	*	west silver bladderpod
Psychrophila leptosepala	PSLE	marsh-marigold
Ranunculus gelidus	RAGE	ice cold buttercup, arctic buttercup, tundra buttercup
Thalictrum heliophilum	THHE2	Cathedral Bluff meadow-rue, sun-loving meadow-rue
Utricularia minor	UTMI	lesser bladderwort
FERNS AND FERN-ALLIES		
Botrychium paradoxum	BOPA9	peculiar moonwort
BRYOPHYTES		
Sphagnum angustifolium	SPAN11	sphagnum, narrowleaf peat moss

*. Names after Weber and Wittmann 2012. †. Codes from USDA Natural Resources Conservation Service 2014.